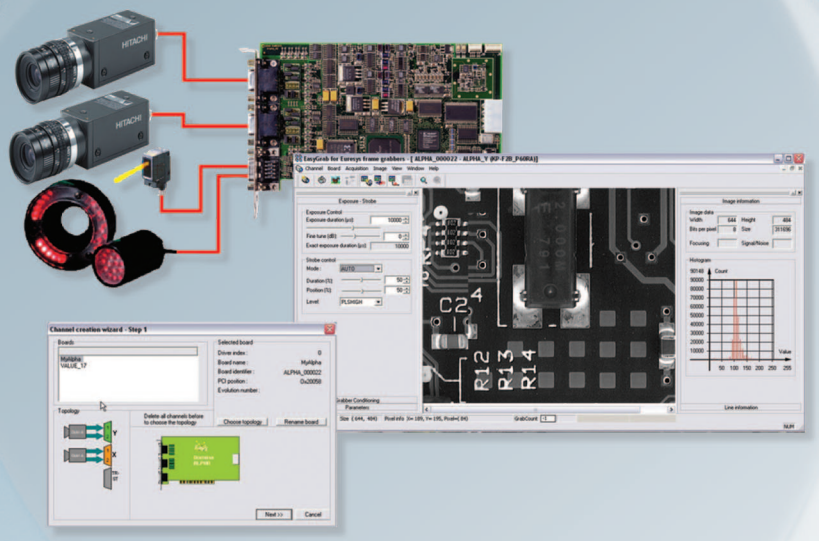
Application Note

MultiCam Acquisition Principles



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MultiCam Acquisition Principles

Contents

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Purpose of this Application Note

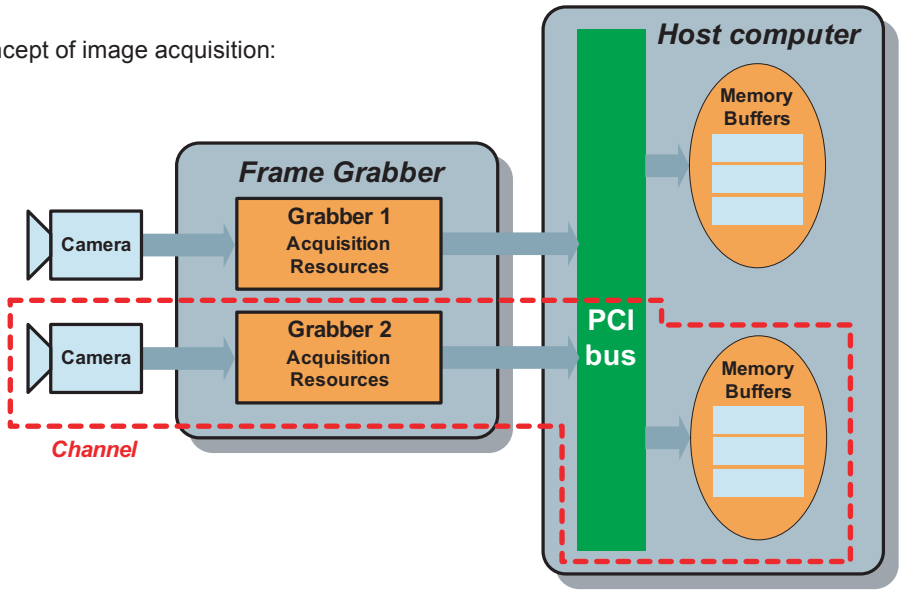
Euresys frame grabbers can be connected to a very large set of commercially available cameras and support numerous operation modes in many system configurations. This interfacing flexibility offers a lot of freedom to the user but selecting the right mode may become difficult. MultiCam is a powerful software tool designed to help the user in this selection process. The purpose of this application note is to explain the MultiCam acquisition mechanisms in a synthetic form. This note provides useful application information complementing the “Euresys Hardware Documentation”.

Channel

Image acquisition in the PC environment is a process involving three main actors:

- a camera responsible for the image capture,
- a frame grabber responsible for the image acquisition and transfer,
- and memory buffers used to store the image in the host PC.

The figure below summarizes the concept of image acquisition:



MultiCam allows control of the full acquisition path between the camera and the host computer memory with a MultiCam object called **channel**. The channel is under the control of the user application. The channel represents what is surrounded by dotted lines on the above picture. All components of the channel are examined below: the camera, the grabber and the memory buffers.

Camera

Basic Features

A camera is a device which transforms the light coming from an observed object into an electrical signal. The camera operation involves an **exposure** period (EXP) and a **readout** period (RDO). The exposure period allows each photosite to build up electrical charges proportionally to the incoming light. The charges accumulation period is often called the integration period. The longer the exposure period, the higher the sensitivity. The readout period allows the stored charges to be extracted from the sensor and transformed into an electrical signal. The readout causes the extraction of all previously accumulated charges from the photosites.

A camera is called **analog** when the electrical signal is mixed with synchronization pulses before being sent to the output of the camera. The output signal is an analog one. In this case the camera is connected to the frame grabber with a coaxial cable. When the electrical signal is digitized before being sent to the output of the camera, the camera is called a **digital** camera. In this case, a dedicated cable composed of several wires able to transfer digital data and synchronization signals connects the camera to the frame grabber.

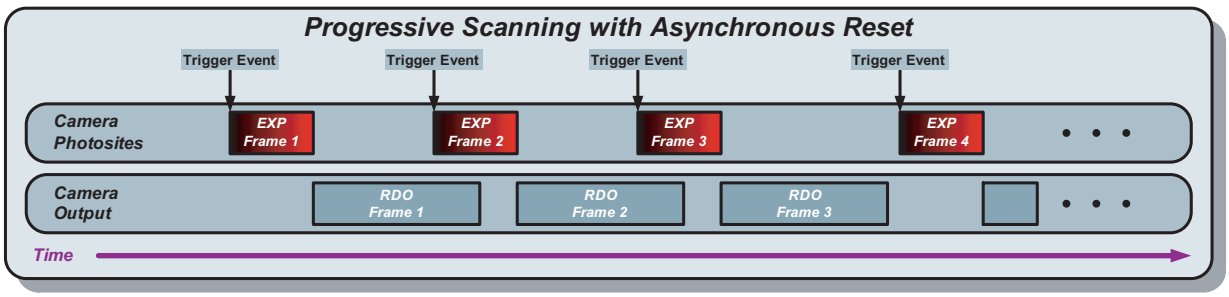
We will explain the camera features by differentiating the area-scan and the line-scan cameras.

Area-scan

An area-scan camera is characterized by a rectangular sensor. The image generated by an area–scan camera is two-dimensional. Area-scan camera sensors typically range from 500x500 to 2000x2000 pixels. One can advantageously split the modes of operation of area-scan cameras into three groups depending on the exposure and readout properties.

Progressive Scanning with Asynchronous Reset

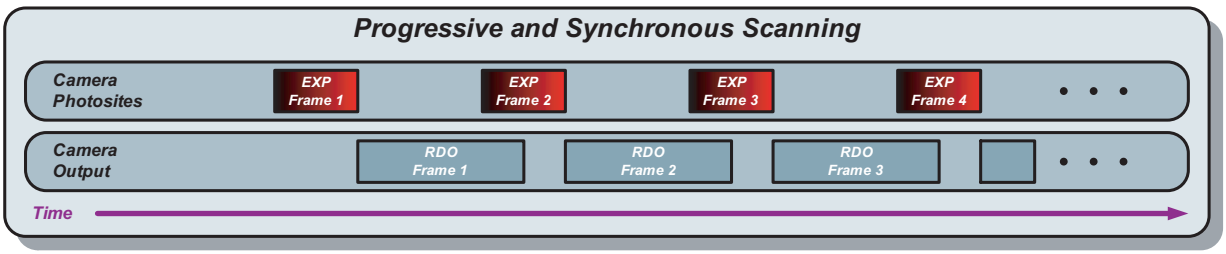
A camera capable of asynchronous reset allows the frame grabber to control the instant of the image capture. In addition, the scanning is qualified as progressive when the sensor is scanned from the first to the last line in a single run. The result of a run is called a **frame**. The following figure depicts the situation:



A trigger event external to the camera marks the beginning of the exposure period. When the camera is able to start an exposure period before the end of the previous readout period, an expose overlap occurs. This mode of operation offers the highest frame rate achievable.

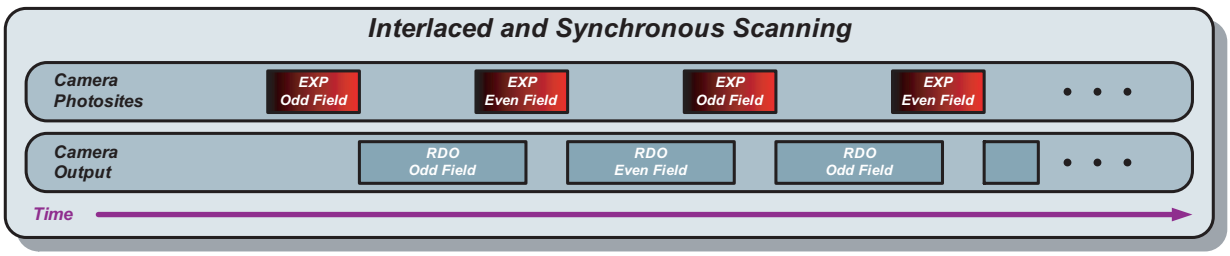
Progressive and Synchronous Scanning

The camera works in synchronous scanning when it -continuously and regularly- issues images to the frame grabber. In synchronous scanning, the time separating each readout period is always very short. The exposure period overlaps the readout period. The following figure depicts the situation:



Interlaced and Synchronous Scanning

During readout, interlaced cameras deliver each captured image in two steps: firstly by successively issuing all odd lines and secondly by successively issuing all even lines. A set of odd or even lines is called a **field**. The captured image is called a frame and is made up of two fields. Nominally, an exposure period takes place between each field. The picture below summarizes the exposure and readout for an interlaced camera.

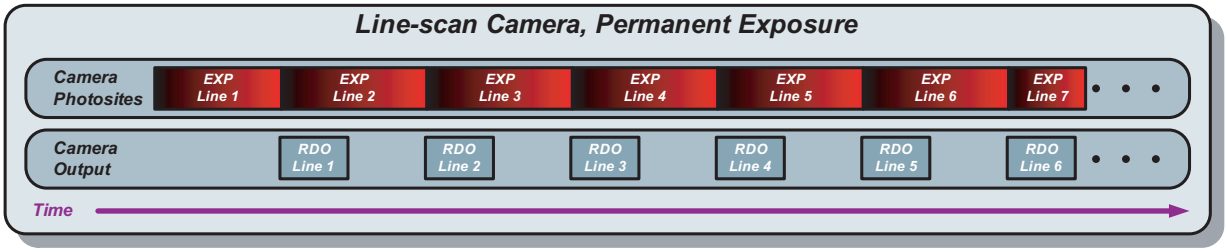


Line-scan

A line-scan camera is characterized by a linear sensor. The pixels are aligned and the camera delivers one image line at a time. By moving the camera over the object to be observed, or by moving the object under the camera, a two-dimensional image can be constructed. Line-scan cameras are well adapted to continuous moving objects analysis. Another advantage of using a line-scan camera lies in the possibility to reach higher resolutions than with its area-scan counterpart. Line-scan camera sensors typically range from 1000 to 10 000 pixels. The exposure and readout of line-scan cameras relate to a line. Depending on the exposure and readout properties, three main modes of operation can be advantageously presented.

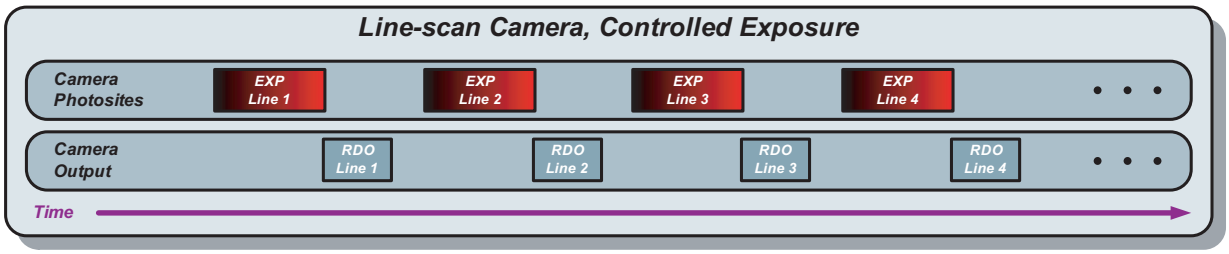
Permanent Exposure

The permanent exposure mode of operation allows the camera sensor to accumulate electrical charges during all the available time. This mode of exposure allows the camera to reach the highest achievable sensitivity. Unfortunately, the sensitivity is dependent on the line rate. The timing diagram below shows the expose and readout operation of a line-scan camera in permanent exposure.



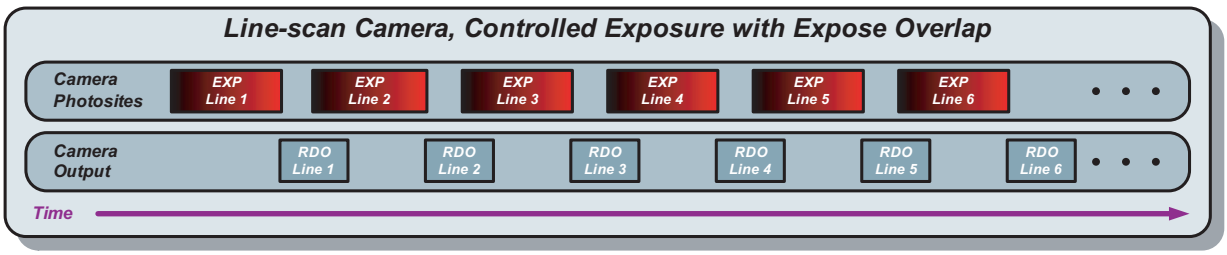
Controlled Exposure Without Overlapping

The controlled exposure allows independent control of the sensitivity (exposure duration) and the line rate. A distortionless two dimensional image is obtained by adapting the line rate to the speed of the moving object. The figure below depicts the situation:



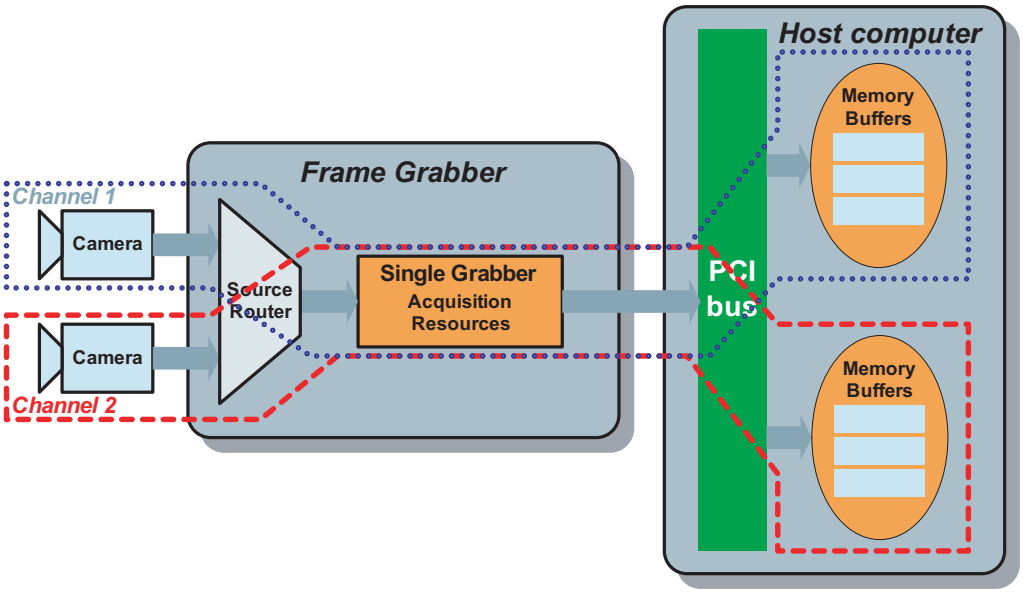
Controlled Exposure With Overlapping

When the line rate has to be increased, the time between readout is not sufficient for the exposure period to take place. The exposure period thus overlaps the readout period:



Grabber

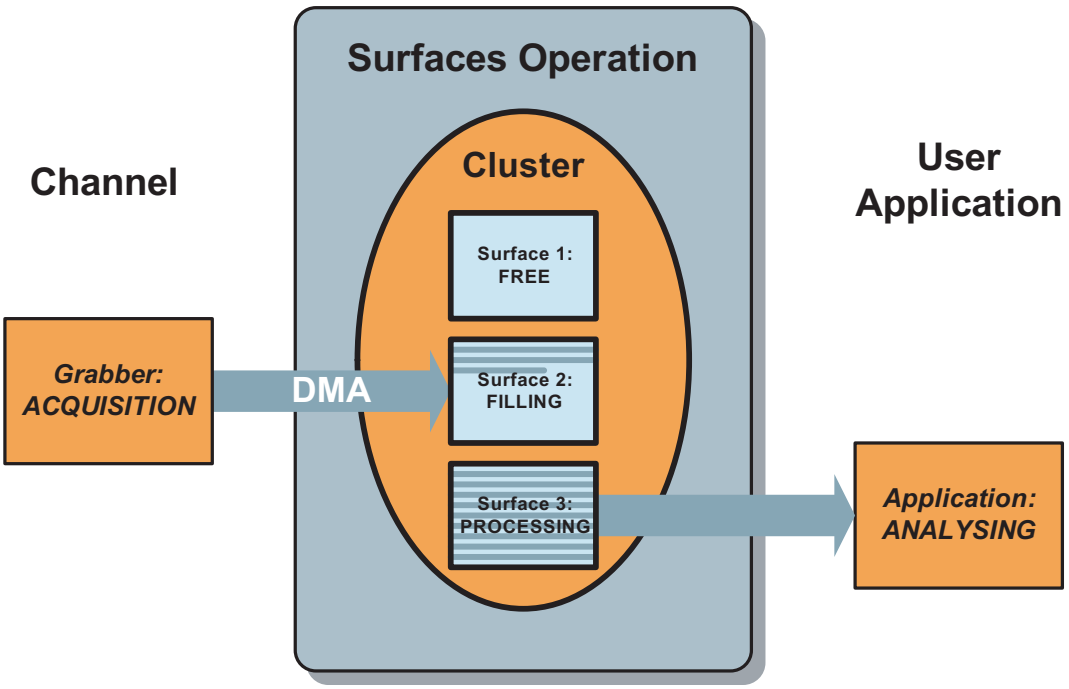
The grabber is the second element of the channel. A grabber is a part of a frame grabber able to read the video signal issued by the camera and to transfer the resulting image to the host PC memory. A grabber is a set of hardware resources used by a channel. As shown on the figure below, some frame grabbers accept a higher number of cameras than grabbers. The grabber acquires the images coming from each camera in turn. The user does not have to worry about the grabber sharing between channels. He only has to create as many channels as he needs. The figure below illustrates the principle with two cameras and one grabber, the channels highlighted in red and blue share the same acquisition resources:



The source router on the figure operates as a switch and allows MultiCam to select one of the two cameras.

Memory Buffers

The last element of the channel consists of destination memory buffers. Memory buffers are represented by MultiCam objects called **surfaces**. The surface is a buffer where the user application can find the acquired image to be analysed. The grabber automatically transfers the acquired image to the destination surface with a DMA mechanism. In efficient implementations, the filling of a surface should be operated while, at the same time, a previously acquired image is analysed by the application. For this purpose, the channel enables to handle several surfaces. A set of surfaces of a channel is called a **cluster**.



The surfaces of a cluster have different states: a surface can be used by the channel for an image acquisition or handled by the user application for image analysing, or it can simply be free. The evolution of these states is managed by state machines inside MultiCam. The application is notified each time a new surface is available for processing.

How to Control the Channel?

MultiCam offers an object-oriented API built around three objects dedicated to the acquisition:

- The **channel** is the fundamental object.
- The **board** is the second MultiCam object. The board contains one or several grabbers intended to serve one or several channels.
- The **surfaces** represent the memory buffers intended to store the images.

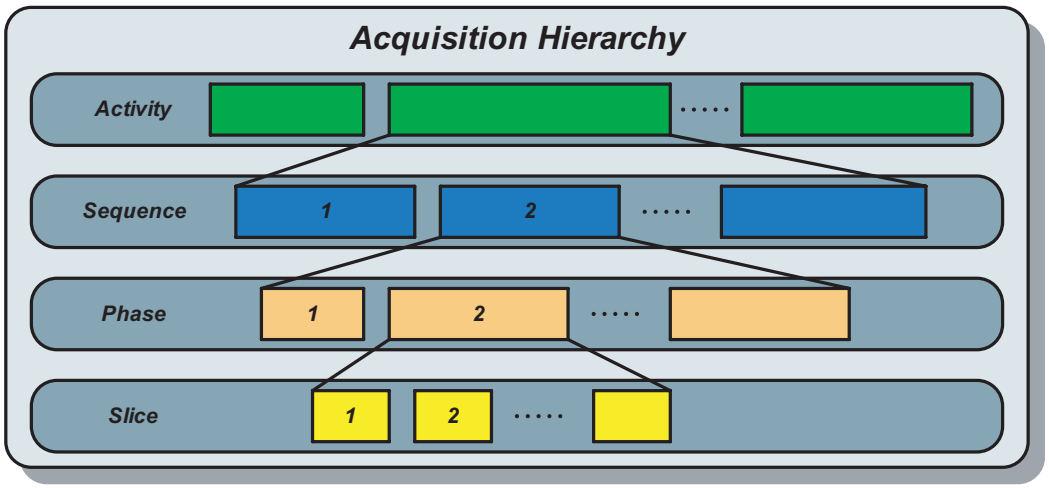
Each object owns an adequate set of **parameters**. The user adapts each object to his image acquisition requirements with these parameters. The user application handles the parameters through the MultiCam API functions. The user application is informed when an event occurs inside an object by mechanisms called **signaling**. The forthcoming chapters focus on channel parameters since they are closely related to the MultiCam acquisition mechanisms.

Acquisition Model

There are many different ways to perform an image acquisition. MultiCam has been constructed to be highly versatile; this section illustrates how this versatility is achieved. The acquisition is exposed with a simplifying model.

Hierarchy

The MultiCam acquisition is a configurable hierarchical process. The general acquisition hierarchy is shown and explained below:



Activity

The channel is a “living” object that can be ACTIVE or not. When the channel is in the ACTIVE state, it performs the acquisition of one or several images during a period called **activity**. When the channel is not in the ACTIVE state, it does not perform any acquisition.

Sequence

The activity period of the channel is divided in smaller sub-activity periods called **sequences**. This name comes from “video sequence” which means a succession of images of a scene.

Phase

The sequences are divided in smaller time periods called **phases**. The essential characteristic of a phase is that it corresponds to the filling of one **surface**.

Slice

Phases may be further divided in smaller sections called **slices**. A surface is filled with several small images (slices) captured at different times. When there is only one slice per phase, the notions of slice and phase are merged. In that case, the term “slice” is dropped in favour of “phase”; this is the most common situation.

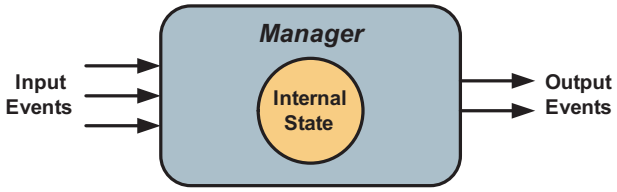
Block Diagram Elements

Events

The acquisition model relies on events. An event is an identified temporal occurrence which arises during the acquisition process. Each event plays a role in the progress of the acquisitions. Events have different sources ranging from user-application-issued events to camera-issued events. Events are represented by arrows in the model. The forthcoming section shows the events needed to understand the principle of the MultiCam event-based model.

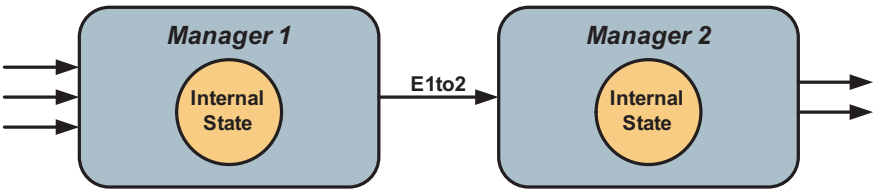
Managers

Managers are black-boxes which react to input events by issuing output events depending on their internal state. The connection of all managers gives a block diagram summarizing the interactions of the hierarchical elements in MultiCam.



Connections

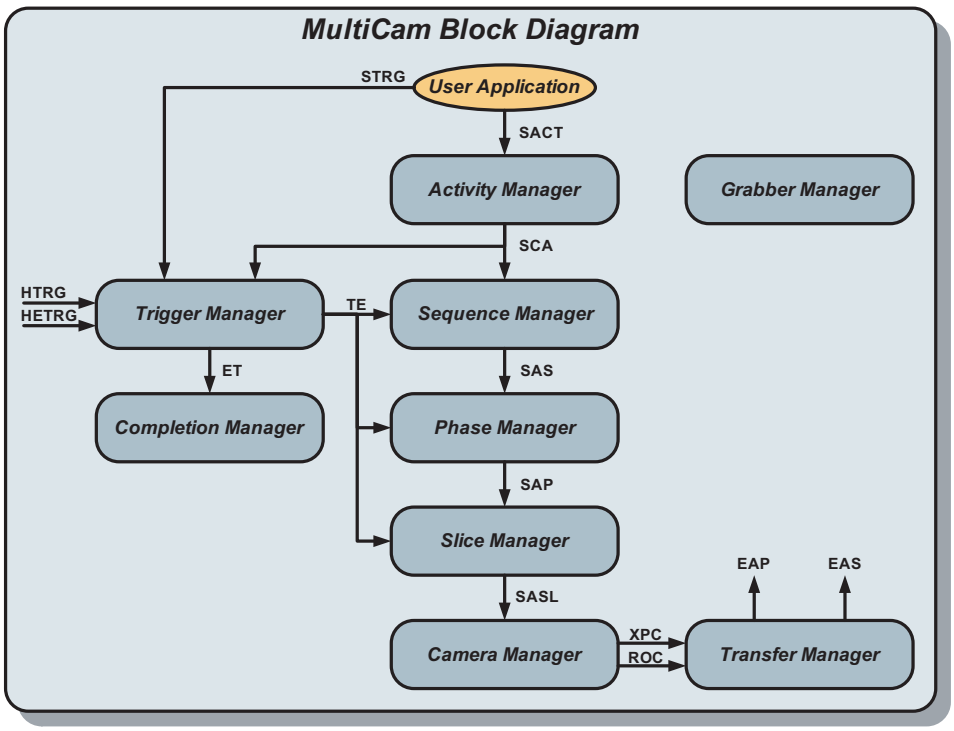
Events connect managers together. The figure below shows a connection between the manager 1 and the manager 2 with event named “E1to2”.



When the managers are connected this forms a block diagram.

MultiCam Block Diagram

The figure below is the interconnected set of managers composing the MultiCam acquisition model. At the top of the block diagram, the user application activates the channel by sending a “Set Active” event (SACT) to the activity manager. This is performed by setting the `ChannelState` parameter to ACTIVE. Once activated, the channel notifies the sequence manager by issuing a “Start of Channel Activity” event (SCA).



The sequence manager gets ready and waits for a “Trigger Event” (TE). The trigger event is generated by the trigger manager when a “Hardware Trigger” event (HTRG) occurs on a selected hardware line. The trigger manager can be configured to introduce some configurable delay on the HTRG event before generating the TE event.

Once triggered, the sequence manager generates the “Start of Acquisition Sequence” event (SAS) to notify the phase manager that the sequence is opened. The phase manager propagates the information by issuing the “Start of Acquisition Phase” event (SAP). The slice manager reacts to the SAP event by issuing a “Start of Acquisition Slice” event (SASL).

The camera manager reacts to each SASL event and performs an expose/readout cycle. The cycle is reported to the transfer manager by the “Expose Completed” event (XPC) and the “Readout Completed” event (ROC). The XPC event marks the end of the exposure and the ROC event marks the end of the readout period of the camera.

The ROC event occurs when the last pixel is issued by the camera. This does not mean that the image data are available for image analysing by the user application. Some time is required to transfer the data to the destination surface through the PCI bus. The transfer manager takes care of this delay and generates the “End of Acquisition Phase” event (EAP) and the “End of Acquisition Sequence” event (EAS) at the right time.

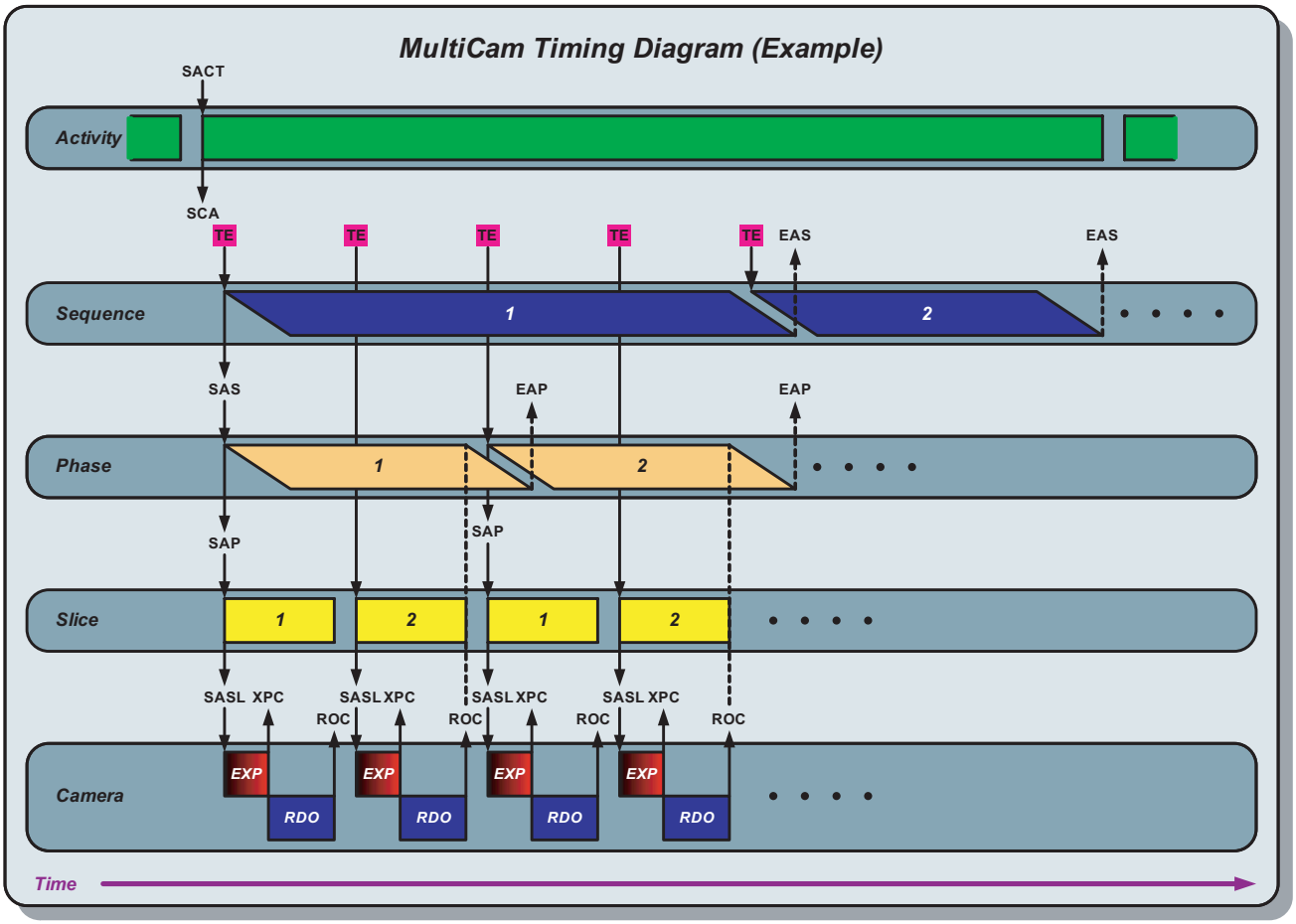
The EAP event notifies the user application that a surface has been filled and is ready for image analysing by the user application. The EAS event indicates that a full sequence has ended and the corresponding surfaces are filled with the sequence of acquired images.

The transfer delay does not affect the system performances since a new phase can be restarted before the EAP event of the previous one has occurred. This phase overlapping is represented with parallelogram on the acquisition timing example in the next section.

The completion manager consists of several counters programmed to inform the other managers when the number of pre-programmed sequences, phases and slices has been reached.

The grabber manager is in charge of informing other managers of the hardware resources availability to serve a dedicated channel.

Timing Diagram



A timing diagram represents the instants of the events occurrences and the associated manager state evolutions. Timing diagrams exist in two flavors in the MultiCam model.

A manager timing diagram represents the events and states belonging to one manager only. A MultiCam timing diagram represents several events and several managers states of the MultiCam block diagram, it shows the evolution of the MultiCam model.

By way of example, the above figure shows one possible MultiCam timing diagram for an area-scan camera. The activity consists of two sequences, the sequence consists of two phases and the phase consists of two slices.

The figure shows the propagation of the trigger event. The trigger principle is very simple: each trigger induces a slice. The trigger effect on the phase and sequence depends on their respective states. If the sequence manager has been waiting for a trigger when a trigger event occurs, the sequence starts and generates the SAS event; otherwise the sequence is not affected by the trigger. The phase manager operates in the same way.

As shown on the figure, the first trigger event generates a succession of events because all managers are waiting for a trigger event.

The second trigger event directly affects the slice manager because the phase and sequence managers are not waiting for a trigger since they are not terminated. The pre-programmed number of slices and phases (2) has not been reached yet. The completion manager monitors this pre-programmed number of phases and sequences.

The table below summarizes the events occurring during an acquisition:

Event	Meaning
EAP	“End of Acquisition Phase”. This event is issued by the transfer manager when the filling process of the destination surface has been completed.
EAS	“End of Acquisition Sequence”. This event is issued by the transfer manager when the filling process of the last destination surface of the sequence has been completed.
ET	“End Trigger Event”. This event is issued by the trigger manager following a “Hardware End Trigger” event (HETRG) when a programmed delay has expired.
HETRG	“Hardware End Trigger”. This event is generated when a dedicated transition occurs on a hardware line.
HTRG	“Hardware Trigger”. This event is generated when a dedicated transition occurs on a hardware line.
ROC	“Readout Complete”. This event is generated by the camera manager when a readout period of the camera is completed.
SACT	“Set Active”. This event is issued when the user application writes ACTIVE in the ChannelState parameter.
SAP	“Start of Acquisition Phase”. This event is issued by the phase manager to notify the beginning of a new phase.
SAS	“Start of Acquisition Sequence”. This event is issued by the sequence manager to notify the beginning of a new sequence.
SASL	“Start of Acquisition Slice”. This event is issued by the slice manager to notify the beginning of a new slice.
SCA	“Start of Channel Activity”. This event is issued by the activity manager to notify the beginning of a new channel activity.
STRG	“Software Trigger”. This event is issued when the user application writes TRIG to the `ForceTrig` parameter.
TE	“Trigger Event”. This event is issued by the trigger manager following a “Hardware Trigger” (HTRG) or “Software Trigger” (STRG) event when a programmed delay has expired.
XPC	“Exposure Complete”. This event is issued by the camera manager when the exposure period of the camera is completed.

Acquisition Control

The acquisition control encompasses all hardware and software mechanisms implemented to start and stop an acquisition. The trigger and the completion managers are the main actors of the control and are therefore more closely studied below.

Starting

The acquisition starting conditions can be configured independently with two parameters:

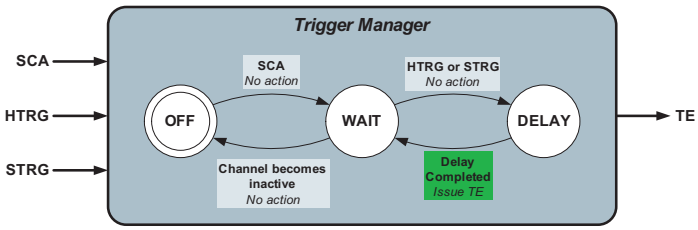
- `TrigMode` configures the starting conditions of a sequence and, consequently, the starting conditions of the first phase or slice of the sequence.
- `NextTrigMode` configures the starting conditions of the subsequent phases or slices of a sequence.

Hardware and Software Trigger Mode

When the `TrigMode` and `NextTrigMode` parameters are set to `COMBINED`, the trigger manager monitors the "Hardware" (HTRG) and "Software Trigger" events (STRG) and generates "Trigger Events" (TE) accordingly. The TE event is monitored as a starting event by the sequence, phase and slice managers. The main goal of the trigger manager is to introduce a delay between the occurrence of a hardware trigger and the TE event. The trigger manager has three states for this purpose:

- OFF: the trigger manager is inactive. When the channel is activated, the trigger manager leaves the OFF state.
- WAIT: the trigger manager is waiting for a HTRG or a STRG event.
- DELAY: this state follows a HTRG or STRG event. The trigger manager counts down a programmed delay before generating a TE event. In line-scan applications, the user can configure the delay according to a line count with the `PageDelay_Ln` parameter. The `TrigDelay_us` parameter offers an alternative to configure a time delay in area-scan.

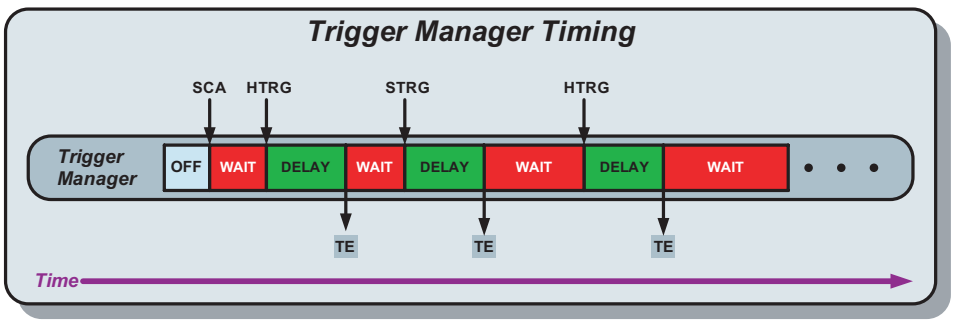
The figure shows the state diagram of the trigger manager responsible for generating the "Trigger" event (TE). The transitions between the states are controlled by the events written in bold characters. The events generated during a transition are written in italics.



The timing diagram of the trigger manager is sketched below to help understand the state diagram.

The trigger manager is in the OFF state until the channel starts (SCA is issued by the activity manager). Once activated, the trigger manager exhibits two behaviors:

- When the HTRG event occurs, the trigger manager goes to a delay state before generating the TE event. The HTRG event is generated from a hardware line. The electrical characteristics of the line are configured with the `TrigLine`, `TrigCtl`, `TrigEdge` and `TrigFilter` parameters.
- When the STRG event occurs, the trigger manager goes to a delay state before generating the TE event. The user application generates the STRG event by writing the `ForceTrig` parameter.



Immediate Trigger Mode

In some acquisition modes, as further described, the sequences, phases and slices have to be started immediately without waiting for a TE event. When the parameter `TrigMode` is set to `IMMEDIATE`, the sequence manager does not wait for TE but starts as soon as the previous sequence has ended. In the same way, when the parameter `NextTrigMode` is set to `REPEAT`, the phase and slice managers do not wait for a TE event before restarting.

Periodic Trigger Mode

The trigger manager is able to generate TE events periodically. This is achieved by setting the `NextTrigMode` parameter to `PERIODIC`. The triggering rate is adjusted with the `TargetFrameRate_Hz` parameter.

This mode of operation allows the frame grabber to perform a kind of under-sampling of the frames issued by a synchronous scanning camera.

Stopping

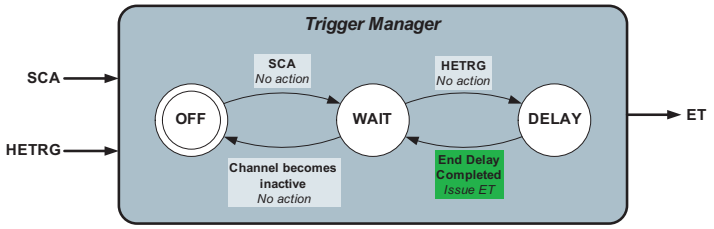
An acquisition can be halted in three ways: end trigger, automatic completion, or user break.

End Trigger

The trigger manager offers a means of stopping an acquisition sequence in reaction to a “Hardware End Trigger” (HETRG) event. The parameter `EndTrigMode` has to be set to HARD for this purpose.

In the same way the trigger manager generates TE, it can also generate an “End Trigger” event (ET) in reaction to HETRG after a configurable delay. The delay parameter is `EndPageDelay_Ln`.

The figure shows the part of the trigger manager responsible for generating the “End Trigger” event (ET).



Automatic Completion

When the parameter `EndTrigMode` is set to `AUTO`, the completion manager is responsible for advising the sequence, phase and slice managers that the acquisition has to end. To perform this job, the completion manager has several counters that it compares to values configurable by the user:

- `ActivityLength`: sets the number of sequence in the activity.
- `SeqLength_Fr`: sets the number of frames in a sequence.
- `SeqLength_Pg`: sets the number of pages in a sequence.
- `SeqLength_Ln`: sets the number of lines in a sequence.
- `PhaseLength_Fr`: sets the number of frames in a phase.

User Break

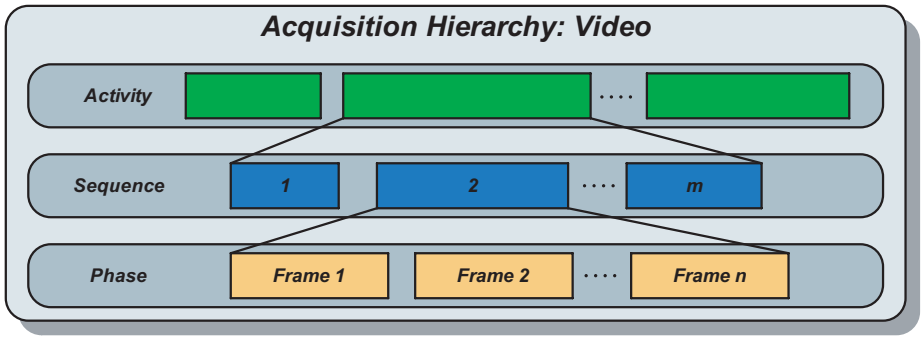
Regardless of the `EndTrigMode` parameter setting, the user can always stop the channel activity by setting it to an inactive state. The `BreakEffect` parameter configures whether the acquisition has to be stopped immediately or has to be delayed at a slice, phase or sequence boundary.

Acquisition Modes

The user can work with a simplified version of the MultiCam model by selecting an acquisition mode.

Video

The Video acquisition mode is dedicated to the automated acquisition of several video sequences. It is a multi-sequence mode applicable to area-scan cameras.



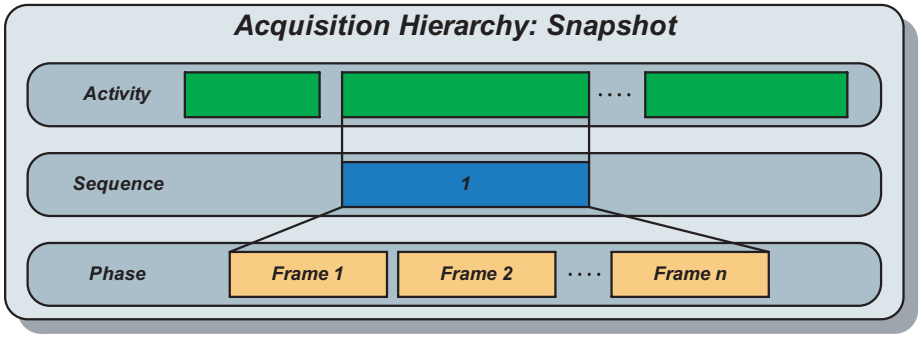
The following table shows the configuration parameters for this mode:

AcquisitionMode = VIDEO					
⇨ ActivityLength	=	**1** <value> or INDETERMINATE			
⇨ PhaseLength_Fr	=	**1**			
⇨ TrigMode	=	**IMMEDIATE** or SOFT			
	=	HARD or COMBINED	⇨ TrigCtl	=	*See MultiCam documentation*
			⇨ TrigEdge	=	
			⇨ TrigFilter	=	
			⇨ TrigLineIndex	=	
⇨ NextTrigMode	=	SAME or SOFT or REPEAT			
	=	**PERIODIC**	⇨ TargetFrameRate_Hz	=	**max** <value>
⇨ EndTrigMode	=	**AUTO**	⇨ SeqLength_Fr	=	**INDETERMINATE** or <value>
	=	HARD	⇨ EndTrigCtl	=	*See MultiCam documentation*
			⇨ EndTrigEdge	=	
			⇨ EndTrigFilter	=	
			⇨ EndTrigLineIndex	=	
⇨ BreakEffect	=	**FINISH**			

Setting `AcquisitionMode = VIDEO` automatically sets the other parameters with the default values written in bold characters. Choosing `HARD` or `COMBINED` for the `TrigMode`, `NextTrigMode` or `EndTrigMode` parameters requires the user to configure some parameters related to the hardware trigger lines. `TargetFrameRate_Hz` determines the acquisition rate in the sequence when `NextTrigMode = PERIODIC`. When `EndTrigMode` is set to `AUTO`, `SeqLength_Fr` determines the number of frames to be acquired in the sequence.

Snapshot

The Snapshot acquisition mode is dedicated to the controlled capture of one or several pictures of one or several objects. It is applicable to area-scan cameras.



The following table shows the configuration parameters for this mode:

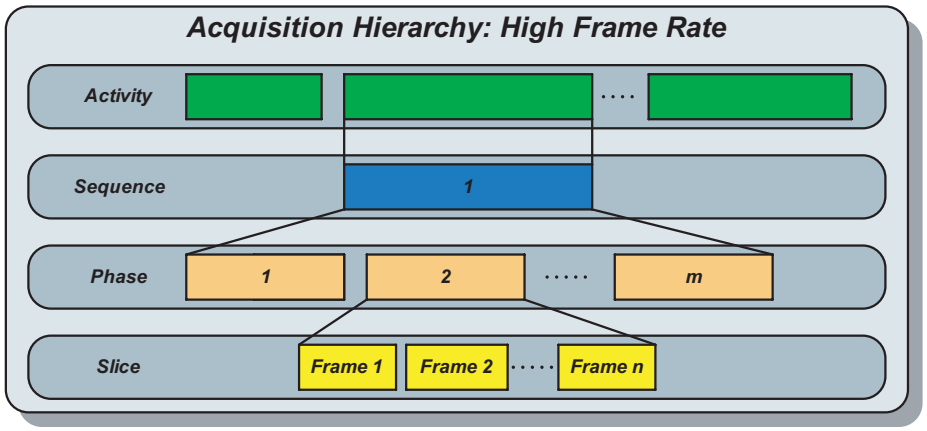
AcquisitionMode = SNAPSHOT					
⇨ ActivityLength	=	**1**			
⇨ PhaseLength_Fr	=	**1**			
⇨ TrigMode	=	**IMMEDIATE** or SOFT			
	=	HARD or COMBINED	⇨ TrigCtl	=	*See MultiCam documentation*
			⇨ TrigEdge	=	
			⇨ TrigFilter	=	
			⇨ TrigLine	=	
			⇨ TrigDelay_us	=	**0** or <value>
⇨ NextTrigMode	=	**SAME** or SOFT or REPEAT			
⇨ EndTrigMode	=	**AUTO**	⇨ SeqLength_Fr	=	**1** <value> or INDETERMINATE
⇨ BreakEffect	=	**FINISH**			

Setting `AcquisitionMode = SNAPSHOT` automatically sets `ActivityLength`, `Phaselength_Fr`, `TrigMode`, `NextTrigMode`, `EndTrigMode` and `BreakEffect` to the value written in bold characters. The mode allows a few parameters to be tuned: `TrigMode`, `NextTrigMode` and `SeqLength_Fr`.

Choosing `HARD` or `COMBINED` for `TrigMode` or `NextTrigMode` requires the user to configure the parameters related to the hardware trigger line (`TrigCtl`, `TrigEdge`, `TrigFilter`, `TrigLine` and `TrigDelay_us`).

High Frame Rate

When a camera delivers the frames at a very high frame rate, the filling of the surfaces also occurs at this rate. This situation can cause an excessive interruption rate of the operating system. The High Frame Rate Mode offers the opportunity to deliver several frames to a same surface. This means that each phase is divided in slices. The interruption rate of the operating system is then divided by the number of slices in a phase.



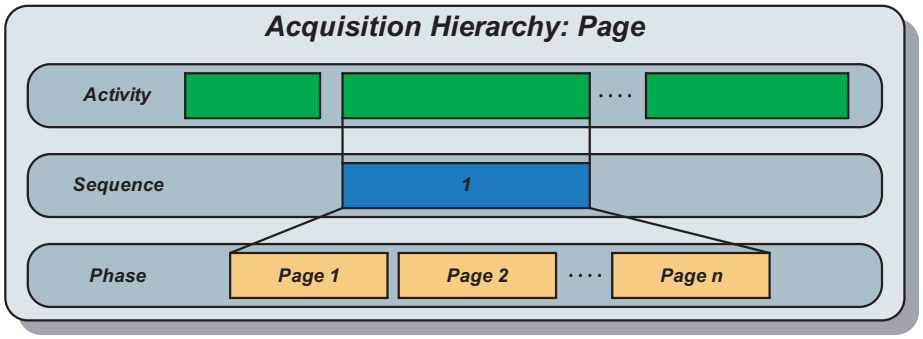
The following table shows the configuration parameters for the mode:

AcquisitionMode = HFR					
⇨	ActivityLength	=	1		
⇨	PhaseLength_Fr	=	<value>		
⇨	TrigMode	=	**IMMEDIATE** or SOFT		
		=	HARD or COMBINED	⇨ TrigCtl	= See MultiCam documentation
				⇨ TrigEdge	=
				⇨ TrigFilter	=
				⇨ TrigLine	=
		=		⇨ TrigDelay_us	= 0 or <value>
⇨	NextTrigMode	=	**SAME** or SOFT or REPEAT		
⇨	EndTrigMode	=	**AUTO**	⇨ SeqLength_Fr	= **INDETERMINATE** or <value>
⇨	BreakEffect	=	**FINISH** or ABORT		

Setting `AcquisitionMode = HFR` automatically sets the other parameters with the default values written in bold characters. The High Frame Rate mode is identical to the Snapshot mode except for the phase length. High Frame Rate allows the phase to be made of several frames by setting `PhaseLength_Fr` to a value between 2 and 256. The number of frames in a sequence is configured by `SeqLength_Fr`. All slices belonging to a same phase are recorded in a same surface.

Page

The Page mode applies to line-scan cameras. It was born from the capture of document pages of identical size. The hierarchy of the page mode is shown below:



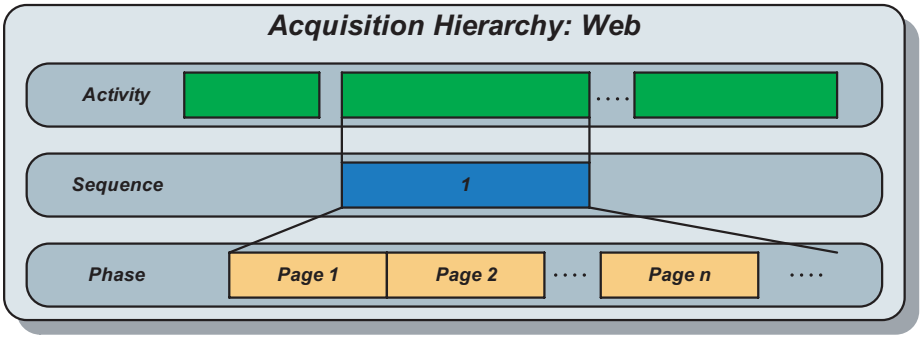
The following table shows the configuration parameters for the mode:

AcquisitionMode = PAGE					
⇨ ActivityLength	=	1			
⇨ PhaseLength_Pg	=	1			
⇨ PageLength_Ln	=	<value>			
⇨ TrigMode	=	SOFT			
		COMBINED or HARD	⇨ TrigCtl ⇨ TrigEdge ⇨ TrigFilter ⇨ TrigLine	= = = =	*See MultiCam documentation*
⇨ NextTrigMode	=		⇨ PageDelay_Ln	=	0 or <value>
	=	**SAME** or SOFT			
⇨ EndTrigMode	=	**AUTO**	⇨ SeqLength_Pg	=	**INDETERMINATE** or <value>
⇨ BreakEffect	=	**FINISH** or ABORT			

Setting `AcquisitionMode = PAGE` automatically sets the other parameters with the default values written in bold characters. Choosing `HARD` or `COMBINED` for the `TrigMode` or `NextTrigMode` parameters requires the user to configure some parameters related to the hardware trigger line and the associated delay (`TrigCtl`, `TrigEdge`, `TrigFilter`, `TrigLine` and `PageDelay_Ln`). `EndTrigMode` is necessarily set to `AUTO` by choosing the Page acquisition mode, `SeqLength_Pg` determines the number of pages to be acquired in the sequence. The `PageLength_Ln` parameter is automatically set to a working value. The user can adapt this value to his requirements but has to read it back for effective setting confirmation.

Web

The Web acquisition mode is dedicated to applications where one object of indeterminate size has to be observed by a line-scan camera. The hierarchy of the web mode is shown below:



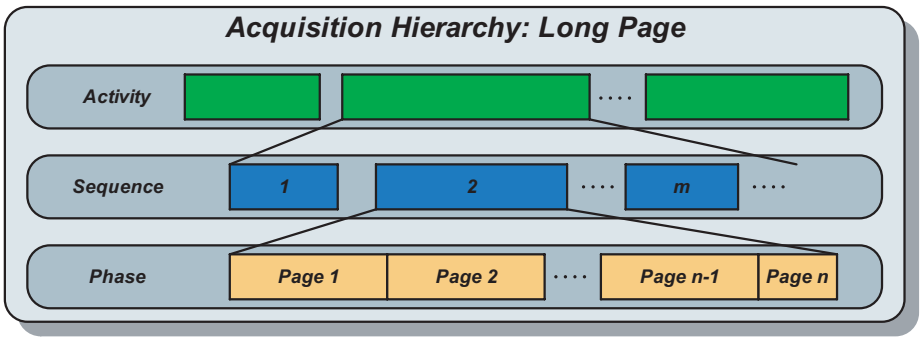
The following table shows the configuration parameters for the mode:

AcquisitionMode = WEB					
⇨	ActivityLength	=	**1**		
⇨	PhaseLength_Pg	=	**1**		
⇨	PageLength_Ln	=	<value>		
⇨	TrigMode	=	**IMMEDIATE** or SOFT		
			HARD or COMBINED	⇨ TrigCtl	= See MultiCam documentation
				⇨ TrigEdge	=
				⇨ TrigFilter	=
				⇨ TrigLine	=
⇨	NextTrigMode	=	**REPEAT**		
⇨	EndTrigMode	=	**AUTO**	⇨ SeqLength_Ln	= **INDETERMINATE** or <value>
⇨	BreakEffect	=	**FINISH** or ABORT		

Setting `AcquisitionMode = WEB` automatically sets the other parameters with the default values written in bold characters. The mode allows a few parameters to be tuned: `PageLength_Ln`, `TrigMode` and `BreakEffect`. `NextTrigMode` is automatically set to `REPEAT` in order to guarantee continuous acquisition in the sequence. Choosing `HARD` or `COMBINED` for `TrigMode` requires the user to configure some parameters related to the hardware trigger line. `EndTrigMode` is necessarily set to `AUTO` by choosing the Web acquisition mode, `SeqLength_Ln` determines the number of lines to be acquired in a sequence. The `PageLength_Ln` parameter is automatically set to a working value. The user can adapt this value to his requirements but has to read it back for effective setting confirmation.

Long Page

The Long Page mode of operation is dedicated to the observation of objects of large but variable size. This is the most powerful acquisition mode for line-scan cameras. The name “Long Page” has been chosen because the pages are assembled to form an equivalent “long page”.



The following table shows the configuration parameters for the mode:

AcquisitionMode = LONGPAGE					
⇨ ActivityLength	=	**INDETERMINATE**			
⇨ PhaseLength_Pg	=	**1**			
⇨ PageLength_Ln	=	<value>			
⇨ TrigMode	=	SOFT			
		COMBINED or HARD	⇨ TrigCtl	=	*See MultiCam documentation*
			⇨ TrigEdge	=	
			⇨ TrigFilter	=	
			⇨ TrigLine	=	
			⇨ PageDelay_Ln	=	**0** <value>
⇨ NextTrigMode	=	**REPEAT**			
⇨ EndTrigMode	=	**AUTO**	⇨ SeqLength_Ln	=	**100000** <value>
		HARD	⇨ EndTrigCtl	=	*See MultiCam documentation*
			⇨ EndTrigEdge	=	
			⇨ EndTrigFilter	=	
			⇨ EndTrigLine	=	
			⇨ EndPageDelay_Ln	=	**0** <value>
⇨ BreakEffect	=	**FINISH** or ABORT			

Setting `AcquisitionMode = LONGPAGE` automatically sets the other parameters with the default values written in bold characters. `EndTrigMode` is available in `Long Page`, it controls the end of a sequence. One should note that the Long Page mode is a multi-sequence mode. The `PageLength_Ln` parameter is automatically set to a working value. The user can adapt this value to his requirements but has to read it back for effective setting confirmation.

A Typical Setup

Procedure

Setting-up a MultiCam acquisition in an application program involves several steps:

When the application starts:

1) Initialize the driver (see `McOpenDriver` in the MultiCam documentation).
2) Create a channel (see `McCreate`).
3) Link the channel to a board (see Board Linkage Parameters).
4) Set the camera parameters. Two methods are proposed: - the scripting method (see `Camfile`)
   - the parametric method (see `Camera` and `CamConfig`)
5) Set the acquisition parameters (see Acquisition Control and Trigger Control Categories).
6) Configure signaling (see `SignalEnable` and `McRegisterCallback`).
7) Start the channel (see `ChannelState`).

When the end of an image acquisition is signaled:

1) Perform custom image analysis, storage, transfer or display.

When the application ends:

1) Stop the channel (see `ChannelState`).
2) Delete the channel (see `McDelete`).
3) Terminate the driver (see `McCloseDriver`).

Sample Programs

Numerous sample programs demonstrate the acquisition modes on many boards. They are available on the Euresys CD and on the web site. They are classified according to the development environment, the board and the acquisition mode demonstrated. For example one can find `GRABLINKExpert2_Web`, `DOMINOAlpha_Snapshot`, `PICOLO_Video` and so on.

Parameters Summary

MultiCam offers a very large set of parameters. These parameters are related to each other: when a high level parameter is modified, an update of lower level parameters may take place. For example, setting the Camera and CamConfig parameters modifies the Scanning, Imaging, Expose, Readout and ExposeOverlap parameters.

Camera Parameters	Meaning
`Camera`	Model of the connected camera.
`CamConfig`	Applied camera settings.
`Imaging`	Camera sensor type method (`AREA, LINE`).
`Scanning`	Camera scanning method (`INTERLACED, PROGRESSIVE`).
`Expose`	Control method of the camera exposure.
`Readout`	Control method of the camera readout.
`ExposeOverlap`	When set, the exposure and readout can overlap.

Acquisiton Control Parameters	Meaning
`AcquisitionMode`	Acquisition mode.
`TrigMode`	Starting condition of an acquisition sequence.
`NextTrigMode`	Starting condition of the subsequent phases or slices of a sequence.
`EndTrigMode`	Termination condition of a sequence.
`BreakEffect`	Stopping condition of the channel activity in case of a user break.
`ActivityLength`	Number of acquisition sequences constituting a channel activity period.
`SeqLength_Fr`	Number of frames to be acquired within an acquisition sequence.
`SeqLength_Pg`	Number of pages to be acquired within an acquisition sequence.
`SeqLength_Ln`	Number of lines to be acquired within an acquisition sequence.
`PhaseLength_Fr`	Number of frames to be acquired within an acquisition phase.
`PageLength_Ln`	Number of scanned lines stored into a surface.
`GrabField`	Field or pair of fields to be acquired in the first phase or slice of the seq.
`NextGrabField`	Field or pair of fields to be acquired in the subsequent phases or slices.

Trigger Control Parameters	Meaning
`TrigCtl`	Electrical style of the hardware line of the starting trigger.
`TrigEdge`	Edge selected as trigger condition (GOLOW, GOHIGH).
`TrigFilter`	Noise removal applied to the trigger.
`TrigLine`	Hardware line of the starting trigger.
`TrigDelay_us`	Delay inserted when a trigger comes from hardware or software (µs).
`PageDelay_Ln`	Delay inserted when a trigger comes from hardware or software (line).
`EndTrigCtl`	Electrical style of the hardware line of the end trigger.
`EndTrigEdge`	Edge selected as an end trigger condition (GOLOW, GOHIGH).
`EndTrigFilter`	Noise removal applied to the end trigger.
`EndTrigLine`	Hardware line of the end trigger.
`EndPageDelay_Ln`	Optional delay inserted before the end trigger.
`ForceTrig`	Generates a soft trigger when set to TRIG.
`TargetFrameRate_Hz`	Triggering rate during an acquisition sequence.

Glossary

Acquisition parameter: an acquisition parameter is a MultiCam item describing the way the frame grabber has to run to satisfy the application requirements.

Activity: an activity is a period of the life of a channel when acquisition can take place.

Analog camera: an analog camera delivers the images in the form of an analog signal.

Area-scan: an area-scan camera delivers a two-dimensional array of pixels.

Asynchronous reset: the asynchronous reset qualifies a mode of exploitation of a camera when the instant of the image capture is under the control of the frame grabber board.

Camera parameter: a camera parameter is a MultiCam item describing the way the frame grabber has to run to satisfy one camera requirement.

Channel: a channel is a MultiCam item representing, by a set of parameters, a path and its activity between a defined camera and a defined cluster of surfaces.

Cluster: a cluster is a set of surfaces associated to a channel and having compatible characteristics.

Digital camera: a digital camera delivers the images in the form of a digital signal.

Event: an event is an identified temporal occurrence which arises during the acquisition process.

Exposure: the photosites of the camera sensor are sensitive to light during the exposure period.

Field: a field is a set of lines issued by a camera having the same parity and representing half of the image.

Frame: a frame is a set of successive lines issued by a camera and representing the image.

Grabber: a grabber is a set of hardware resources of a frame grabber required to transfer the image issued by a camera to the PC memory.

Hierarchy: the hierarchy is one view of the MultiCam acquisition.

Interlaced: an interlaced camera delivers a two dimensional array of pixels by issuing the even and the odd lines separately.

Line-scan: a line-scan camera delivers a one-dimensional array of pixels.

Manager: a manager is a black-box which reacts to input events by issuing output events according to its internal state.

MultiCam: MultiCam is a software tool designed to assist the customer in controlling image acquisition with every Euresys frame grabber.

Page: a page is a set of successive lines issued by a line-scan camera and stored in the same surface.

Phase: a phase is the capturing process of a set of slices associated to a surface.

Progressive: a progressive camera delivers a two-dimensional array of pixels by successively issuing adjacent lines.

Readout: the camera delivers the sensed image at its output connector during the readout period.

Sequence: a sequence is the capturing process of a set of phases.

Signal: a signal is a MultiCam item representing a particular event occurring at a precise instant and intended to interact with the software application.

Slice: a slice refers to the capture of a set of successive lines. It is the smallest bi-dimensional unit issued by an extremely fast camera.

Surface: a surface is a MultiCam object representing a memory buffer. This buffer is used as a container for the acquired images.

Synchronous scanning: the camera operates in synchronous scanning when the instant of the image capture is periodic and controlled by the camera.

Triggering: triggering includes all mechanisms related to the starting and ending conditions of acquisitions.

Application Note,

MultiCam Acquisition Principles

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