IEEE-1394
High Speed Serial Network

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IEEE-1394 Key Features

- High Bandwidth
- Deterministic
- Flexible dynamic topology
- Many devices per network
- Small connector and cable
- Open protocol

IEEE-1394 == Deterministic

Isochronous transfer

Guaranteed Bandwidth

Time critical data (video, audio, …)

One to All; broadcast

Asynchronous transfer

Guaranteed Delivery

Content critical data (commands, files, …)

One to One; confirmed messaging

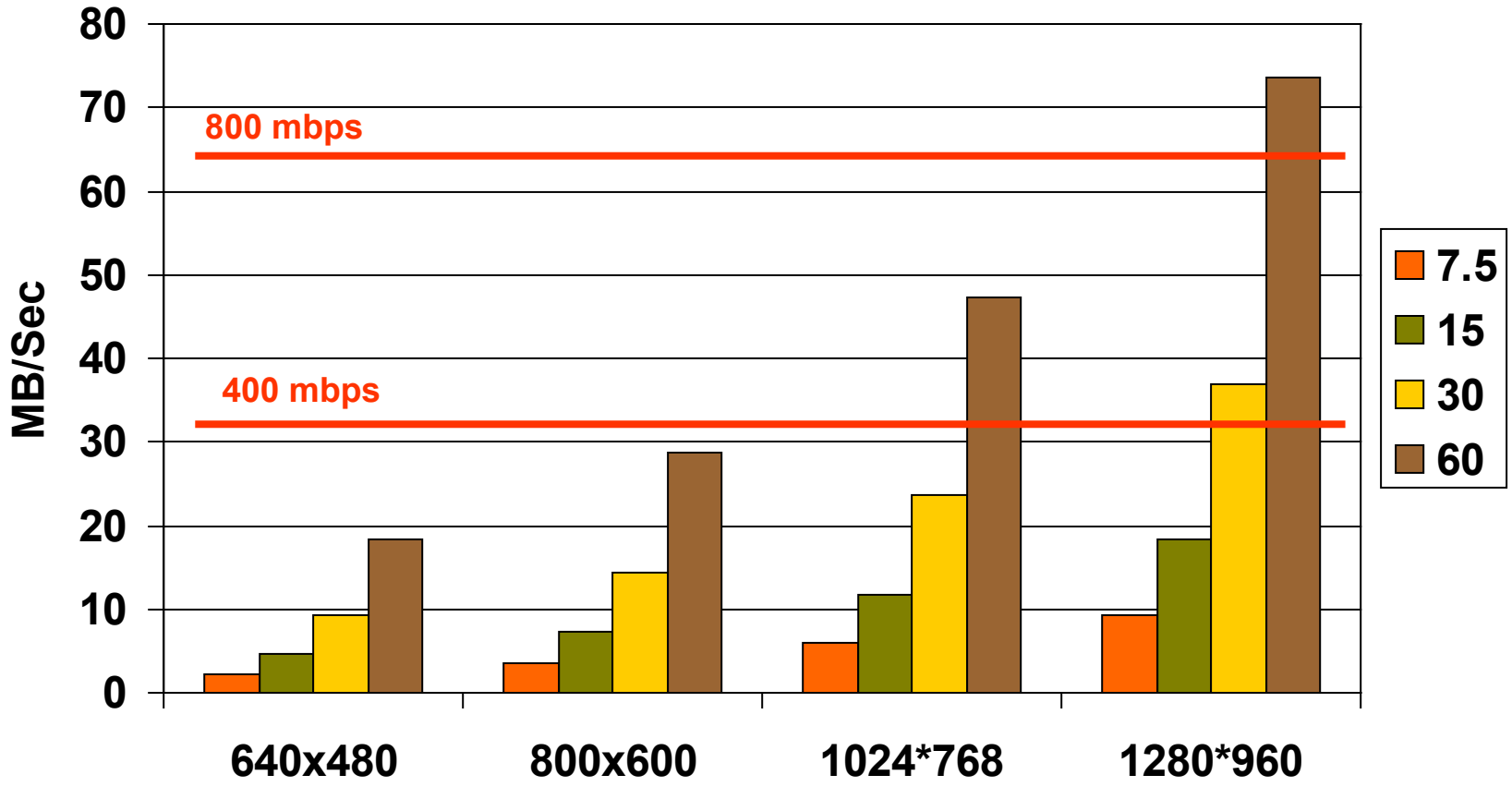
IEEE-1394 employs both methods of data delivery

IEEE-1394 == Bandwidth

High Speed / High Throughput:

- Current data transfer rates (1394a)
  - 100, 200, and 400 Mbits/sec
  - (~10, 20, and 40 MBytes/sec)
  - 80% available for video (ISO transmission)
- New transfer rates (1394b)
  - 800, 1600, 3200 Mbits/sec

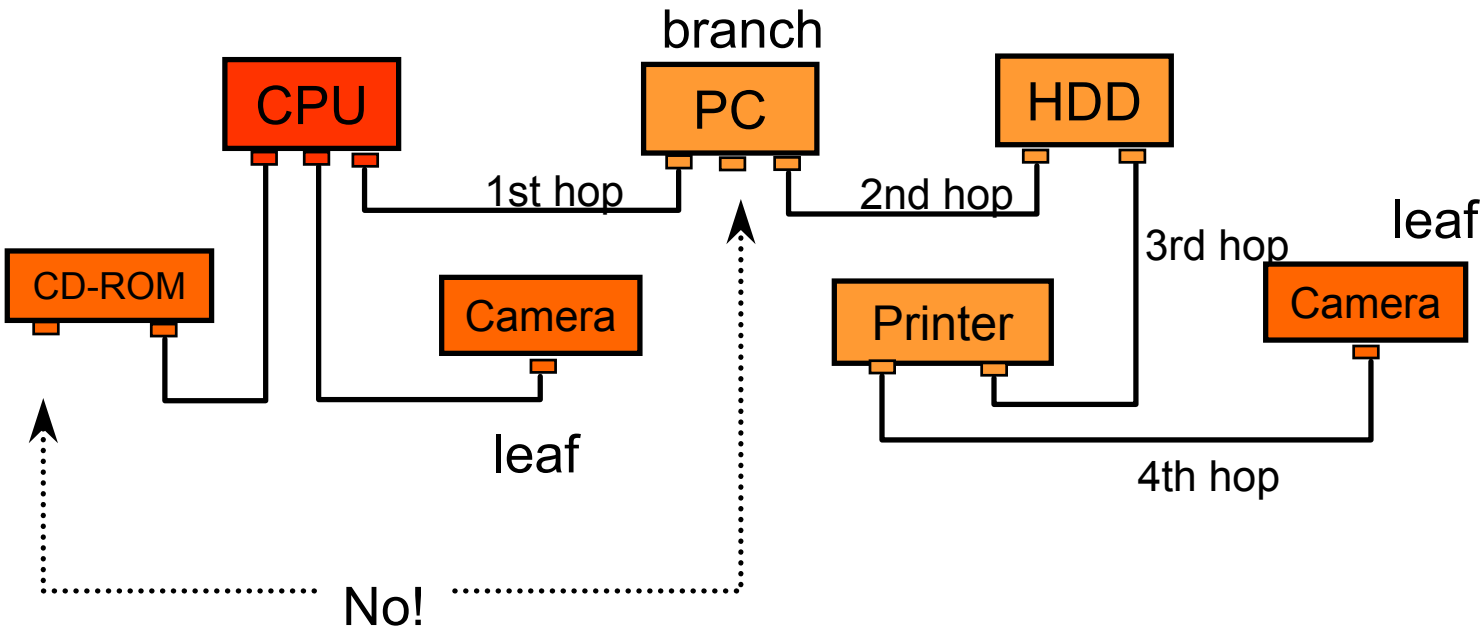
Bandwidth for Mono8 Camera



IEEE-1394 == Flexible Topology

Tree or star network topology

- Up to 63 devices per bus
- Peer-to-peer (multiple CPUs)



IEEE-1394 == Easy

Dynamic, unsupervised network

- Hot pluggable
- Plug & Play
- Automatic reconfiguration:
  - No requirement to reboot
  - No need for ID switches or addresses

IEEE-1394 Cables & Connectors

1394a connectors:

- **4 pin** — **No power**

- **6 pin (original)** — **Powered**
- **6 pin latching**
- **6 pin latching hardened**

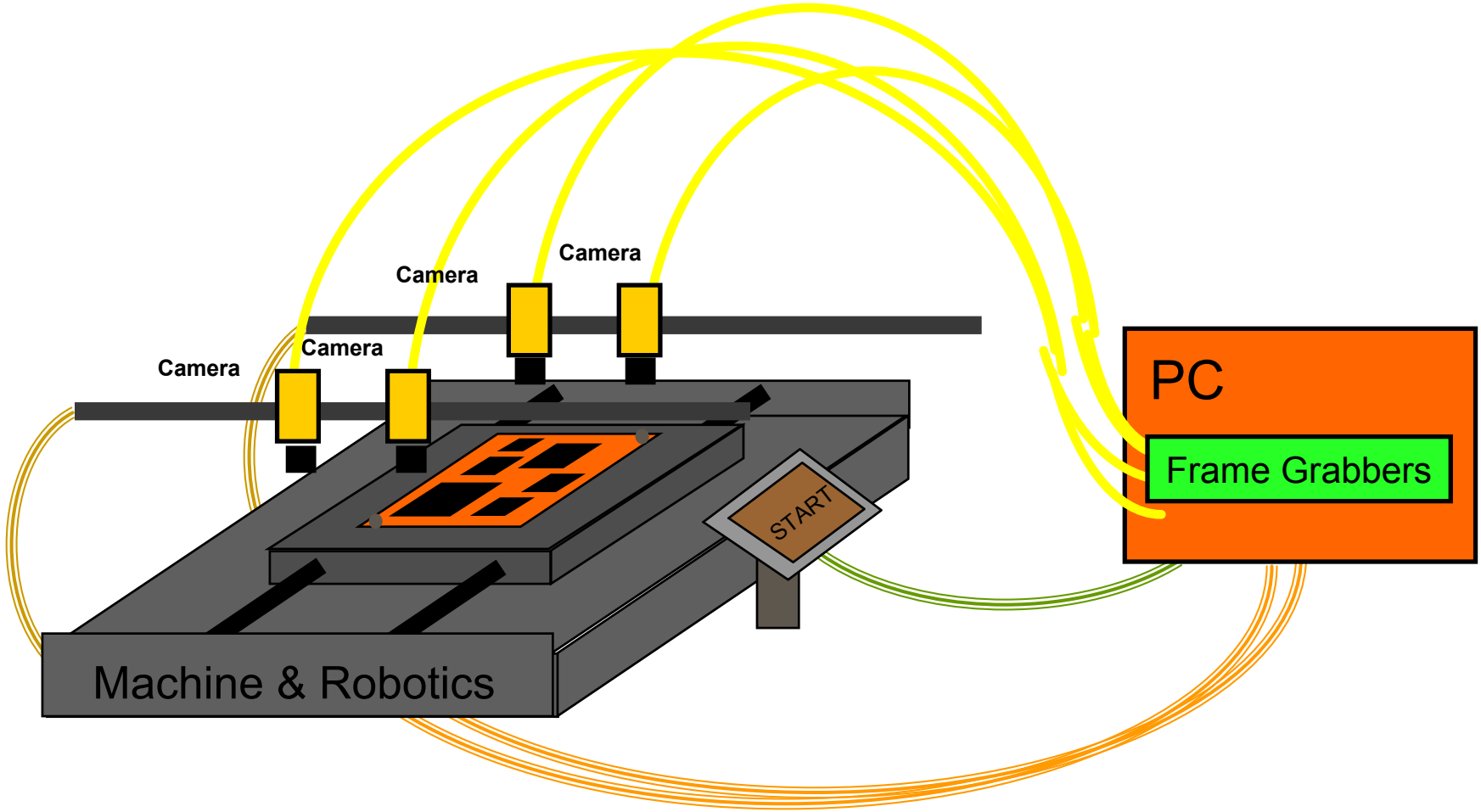
1394b connectors:

- **9 pin – Beta or Biligual (both with power)**

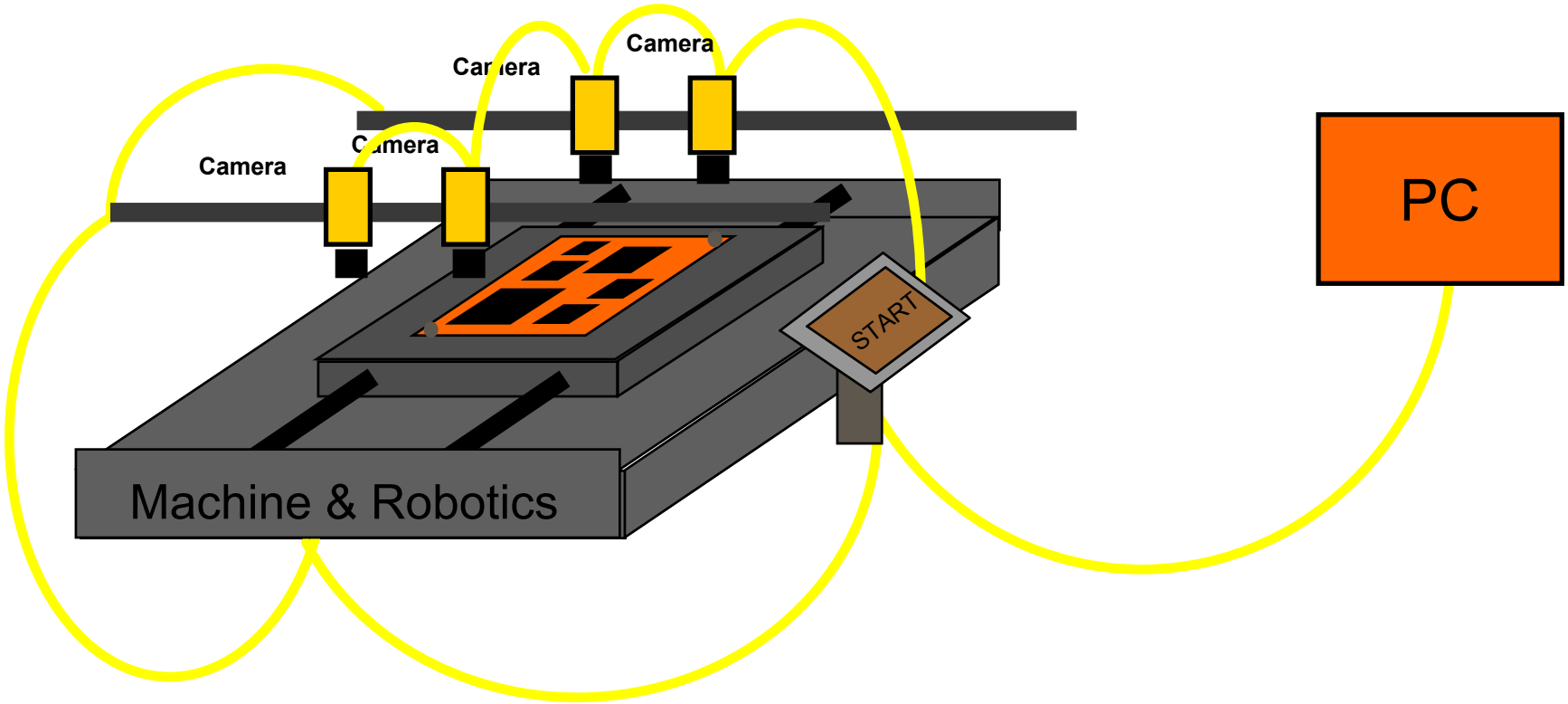
Connection methods

	1394	*USB 1 / 2*	*CameraLInk*
Type	Network Peer-to-peer	Network Master-Slave	Point-to-Point
Bandwidth (MB/s) ***(In future)***	~10, 20, 40 (~80, 160)	~1 / ~40	255, 382, 680 (?)
Wires/cable	4/6 pin STP standard	4 pin STP standard	26*1 or 2 standard
Length ***Max with hubs*** ***- Fiber Optics***	4.5 m 72 m ~500 m	5 m 30 m	10 m
Devices	63	127	1
Interface	Built-in, PCcard, PCI, …	Built-in, PCcard, PCI, …	PCI
Power	0-1.5 A @ 8-30 V	500ma @ 4.7Vdc	none

Using Point-to-Point Connections



Using Network Connections



Why use a Digital Camera

- Want to use digital camera
- Reduce or simplify cabling
  - Overall system cost may be lower
  - Network versus many boards and cables
- Remote control of camera settings
- Higher resolution, non video format
- Flexibility of high resolution or high rate
- Work with smaller, slotless computers

1394 Camera types

- DV cameras:
  - Consumer camcorders & low end cameras
  - Compressed for easy storage, low bandwidth
  - Supported by lots of DV SW/HW
- Digital Still cameras:
  - Capture to camera memory
  - Read from camera memory to computer
  - Compressed or uncompressed
- IIDC/DCAM cameras:
  - Capture and send to computers
  - Uncompressed mono or color

IEEE-1394 Myths

- Need longer cables
  - 4.5 m * 16 cables = 72 m
  - 10 m works with fewer hops
  - 15-25 m with better cable - no hops
  - 50-500 m with POF/GOF bridges
  - no limit on distance with 1394b

IEEE-1394 Myths

- Need more bandwidth for multiple camera
  - Up to 63 devices per bus
  - 4 to 32 Isochronous channel; 4 typically
  - Select camera(s) to transmit images
  - Reduce frame rate or resolution
  - Additional 1394 HACs - more bandwidth

IEEE-1394 Myths

- Need to trigger fast
  - Trigger input directly to camera
  - Low latency (less than 4 microsecond)
  - Short exposure (to 1/100000 sec)
  - Software control of exposure and trigger ON
  - Fast software trigger (<1 millisec) available

IEEE-1394 Myths

- Can not synchronize:
  - Cameras can self sync on 1394 bus clock
  - Cameras can be HW triggered at full rate
  - ExposingOut at camera to Strobe, …

IEEE-1394 Myths

- Limited choice of suppliers and software
  - Computers with embedded 1394
    - Sony, Matrox, NI, Compaq, …
  - SW and HACs from multiple vendors
    - Matrox, NI, Unibrain, FASE, …
  - Multiple camera vendors
    - Sony, Basler, Pt. Grey, PixelLink, TheImagingSource,
    - Cohu, Q-Imaging, Optronics, AVT, Teli, …
  - Many successful installations

1394 Third Party Software

Matrox
National Instruments
Unibrain
FASE
TheImagingSource
IoIndustries
Linux 1394 Project
CMU open source

IEEE-1394 DCAM Cameras

	DFW-X700	DFW-SX900	XCD-X710CR	XCD-SX910CR	XCD-X710	XCD-SX910
Type	Color	Color	Color-Raw	Color-Raw	Mono	Mono
CCD	1/2” Prog Scan	1/2” Prog Scan	1/3” Prog Scan	1/2” Prog Scan	1/3” Prog Scan	1/2” Prog Scan
Resolution	1024x768 YUV:422	1280x960 YUV:422	1024x768 Mono:8 Mono:10	1280x960 Mono:8 Mono:10	1024x768 Mono:8 Mono:10	1280x960 Mono:8 Mono:10
Frames/sec **Binned**	15	7.5	30 50	15 30	30 50	15 30
Lens/Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount	C-Mount
CCD Iris	Yes	Yes	Yes	Yes	Yes	Yes
Ext. Trigger **SW. Trigger** **Auto Sync**	Yes Yes - VD	Yes Yes – VD	Yes Yes – fast Yes	Yes Yes - fast Yes	Yes Yes – fast Yes	Yes Yes - fast Yes
Partial Scan **Faster f/s**	Yes	Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes

1394 interface

Good range of cameras from many vendors

Many support components available

Lower cost flexible network configuration

Data and power on single bus/cable

Performance for many MV applications`

Sony Imaging Solutions @ Work

Thank You.