Active Networking:
A 2020 Vision
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Outline of talk

The human I/O architecture
- basic properties
- technical implications

Active Networks
- information movement + processing

"2020 vision"
- higher human I/O!

Human I/O architecture

☐ High-bandwidth video input
- ✉ feeds slow symbol processor (Card, et al)
- ✉ asymmetric - no fast video out!

☐ Audio input/output (100 kilobits/sec)

☐ Other senses (touch, smell, taste…)

☐ The asymmetry is HUGE (10-1000)

☐ Lots of intermediate filtering

Technology echoes biology...

- Newspapers
  - Many readers, few writers
- Television
  - Video out, remote control in
- Web
  - Video, etc. out, text/clicks in
- Coupled to I/O architecture!

Optimally

- Information flows in audio/video
- Information flows out audio (speech recognition *should* be faster than keyboarding!)
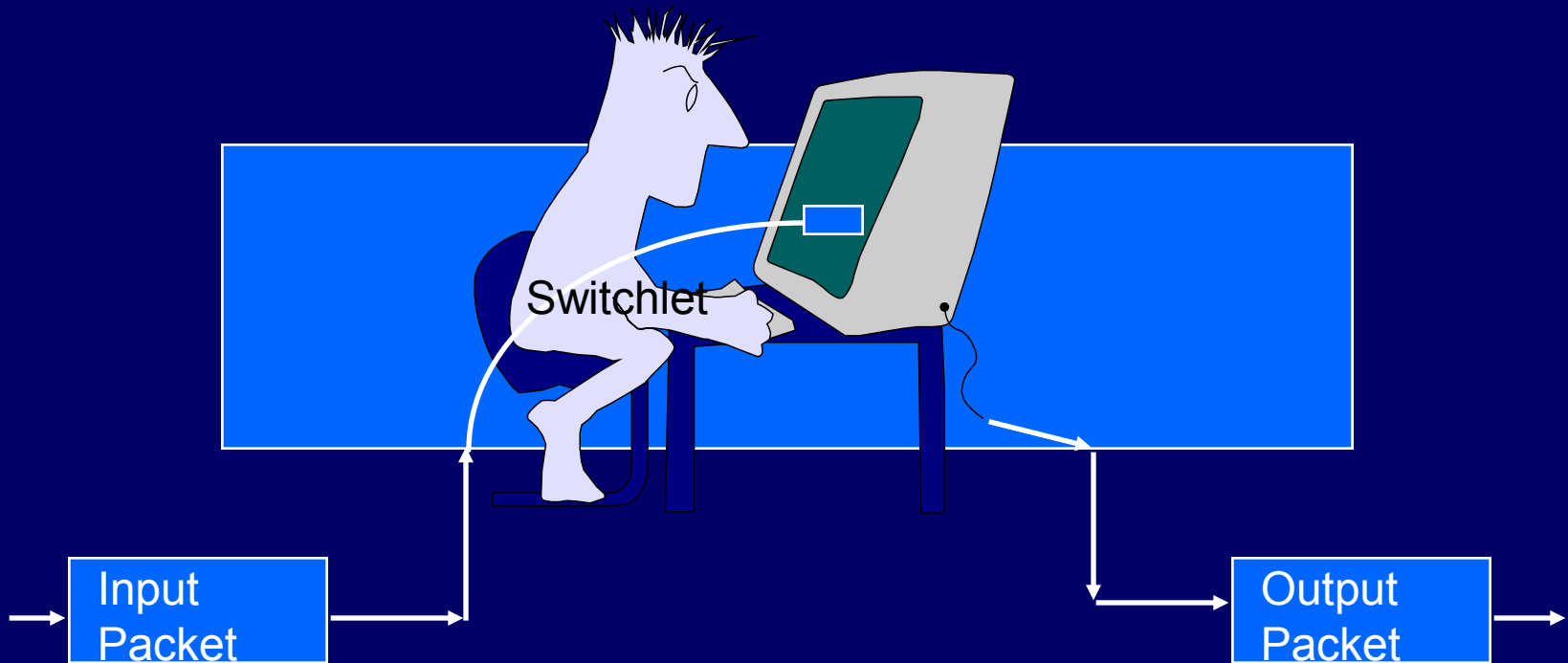- Information systems get the "best" (necessary, relevant, etc.) information to the presentation point (eyes, ears)

"Passive" Networking

☐ Smart hosts on the edges
☐ Passive switches in the center
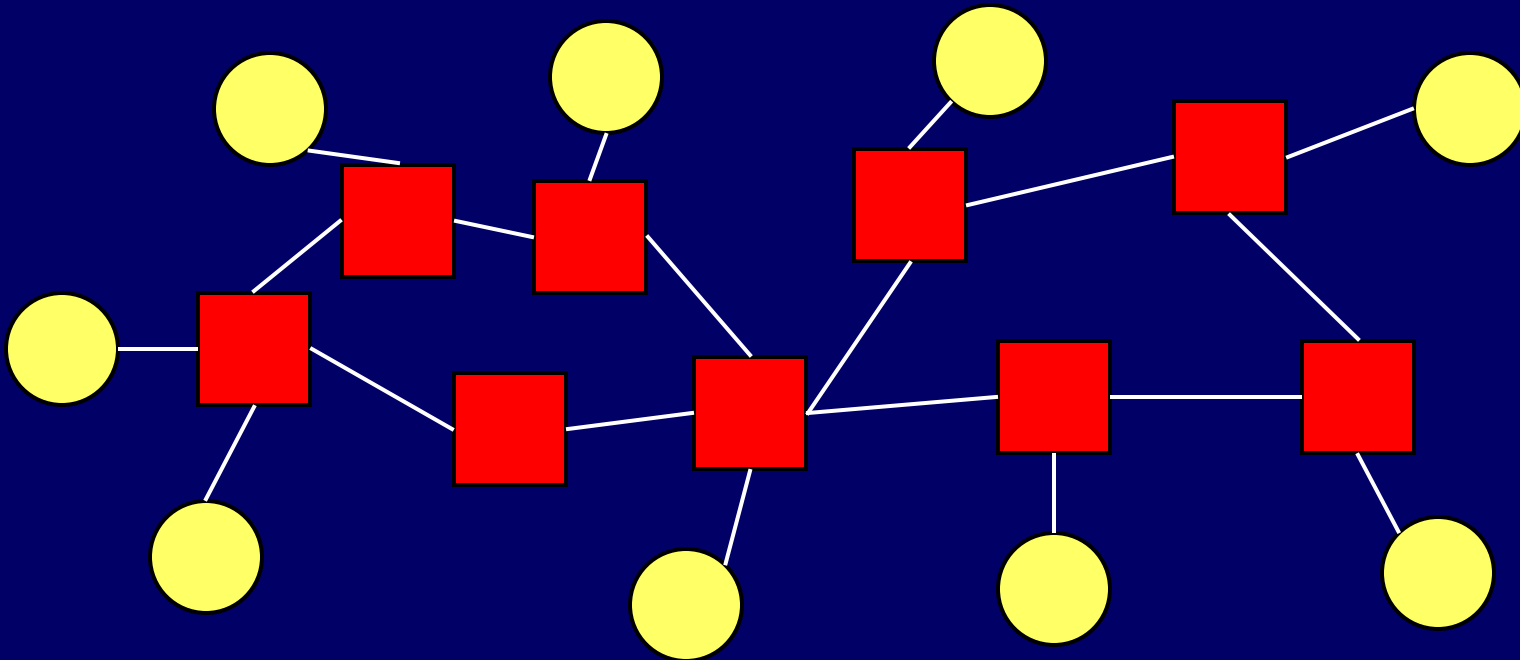
Active Networking Nodes

Store, COMPUTE and Forward!

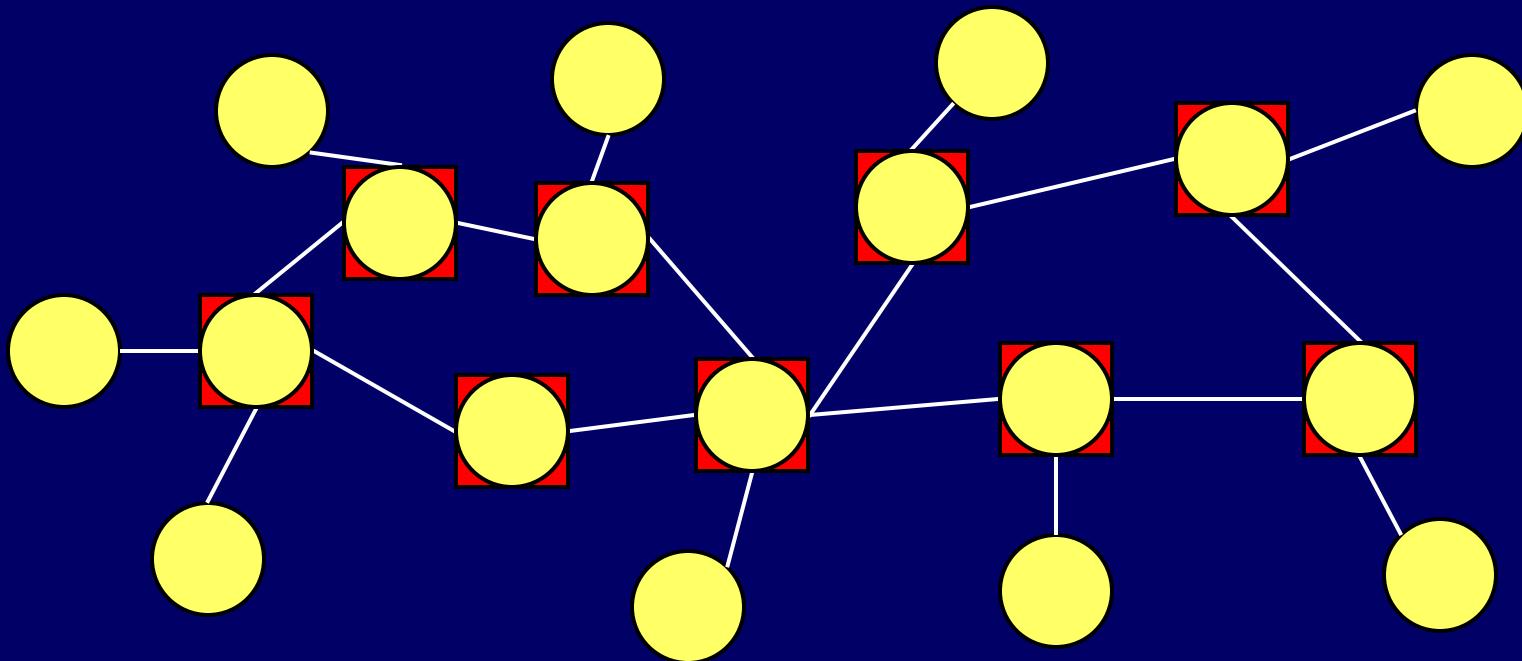Switchlet

Input Packet

Output Packet

Active Network Model

☐ Packets ("switchlets") can change the behavior of the switches "on-the-fly"

  ✉ In-band active packets
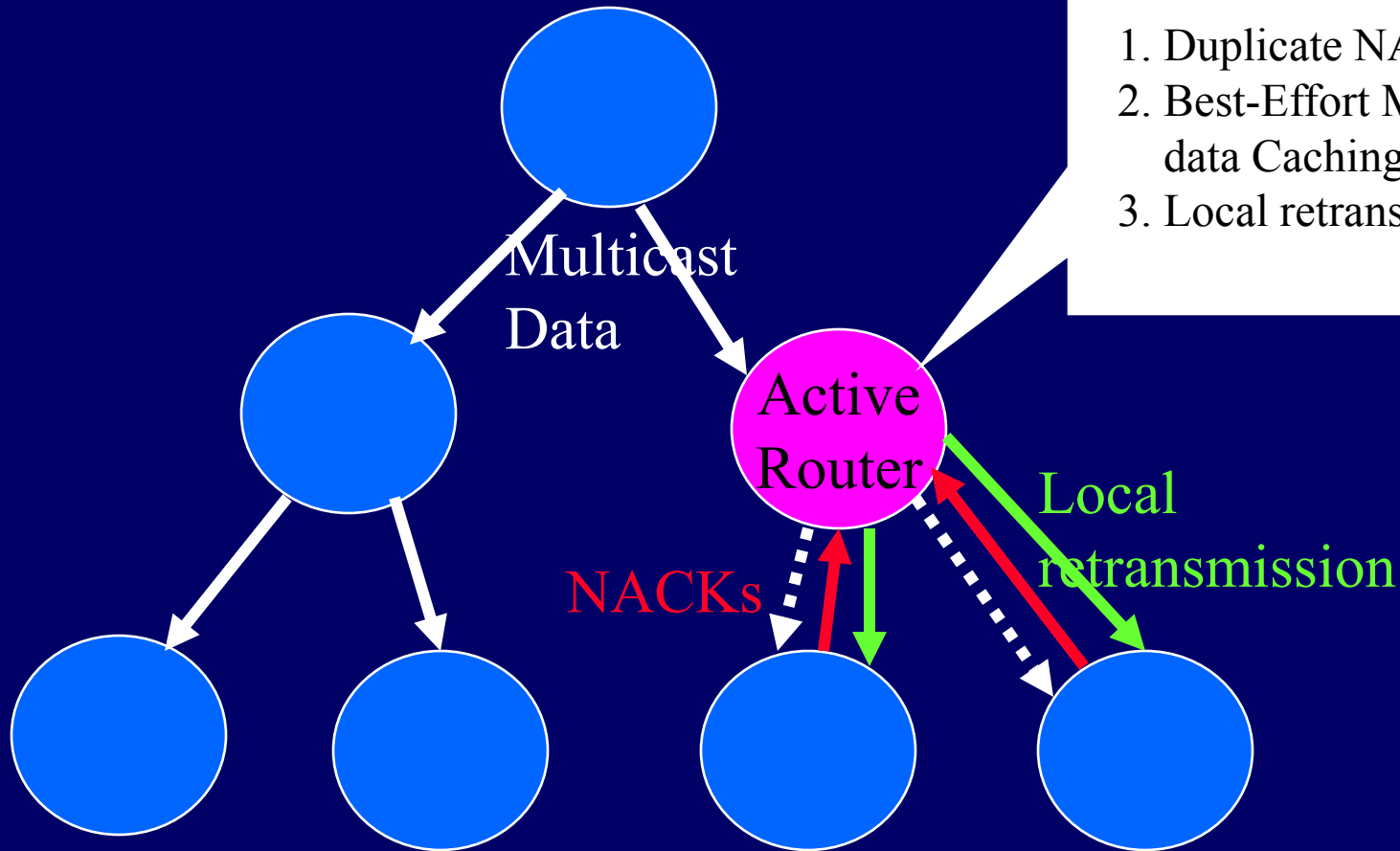
  ✉ Out-of-band active extensions

Why Do This?

☐ Faster response to problems and possibilities in network

☐ Per-user protocols

☐ Allows experimentation

☐ Accelerates network evolution

☐ Example Applications

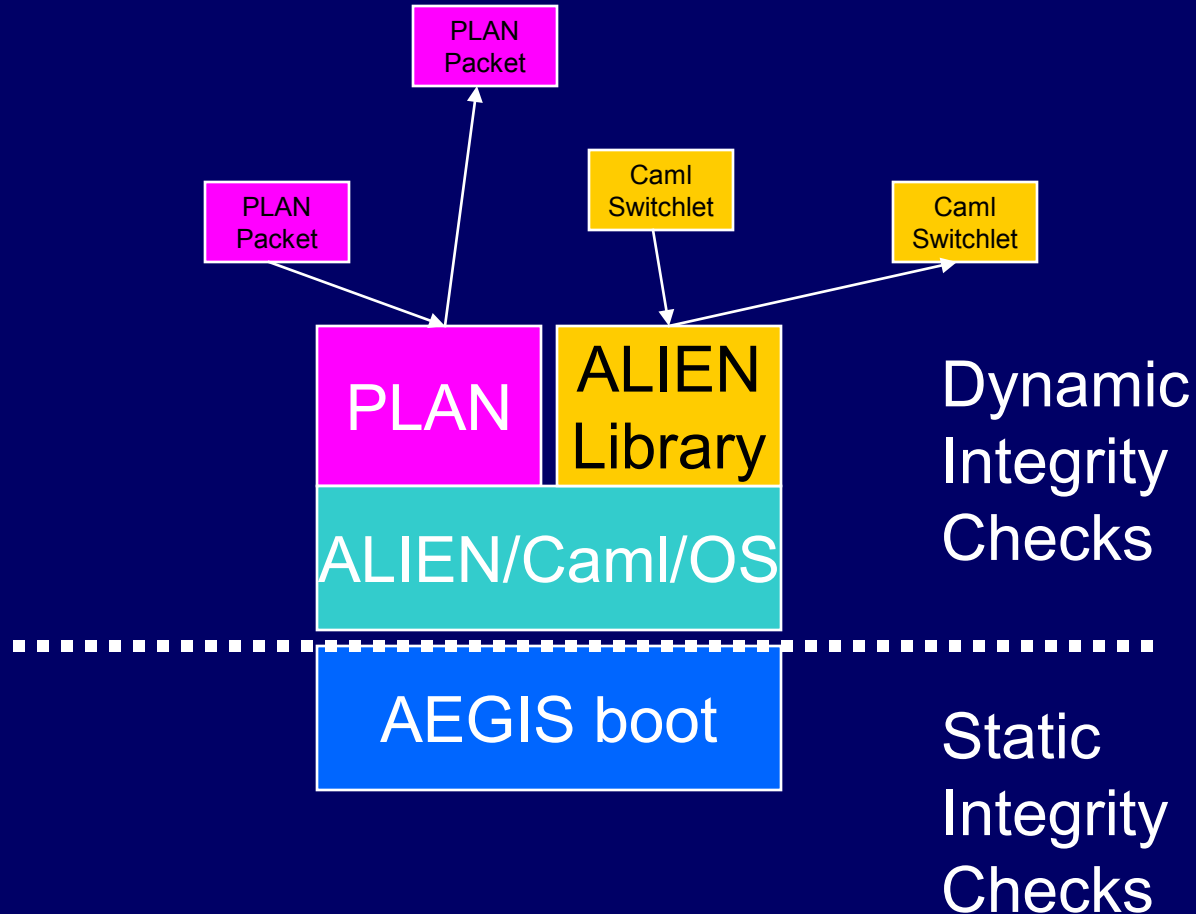 - Auctions
  - Reliable multicast
  - Sensor Fusion

An Example Active Application: Active Reliable Multicast (ARM)

☐ Reliable Multicast plagued by "ACK implosion" when an error occurs

☐ Retransmission expensive

☐ In MIT's ARM, Active Elements are embedded in the multicast tree (not all tree nodes need be active for ARM to work)

ARM techniques

1. Duplicate NACKs
2. Best-Effort Multicast data Caching
3. Local retransmission

Multicast Data

Active Router

NACKs

Local retransmission

Example: SwitchWare Architecture

PLAN Packet

PLAN Packet

Caml Switchlet

Caml Switchlet

PLAN

ALIEN Library

ALIEN/Caml/OS

AEGIS boot

Dynamic Integrity Checks

Static Integrity Checks

http://www.cis.upenn.edu/~switchware

Activation potential at various commercially deployed rates:

POTS/ISDN
T1
10M Ethernet
OC3
OC12
OC192

More Nodes

Increasing Traffic Aggregation

Increasing SW Service Deployment Times

Increasing Preference for SW Restriction to Control Plane
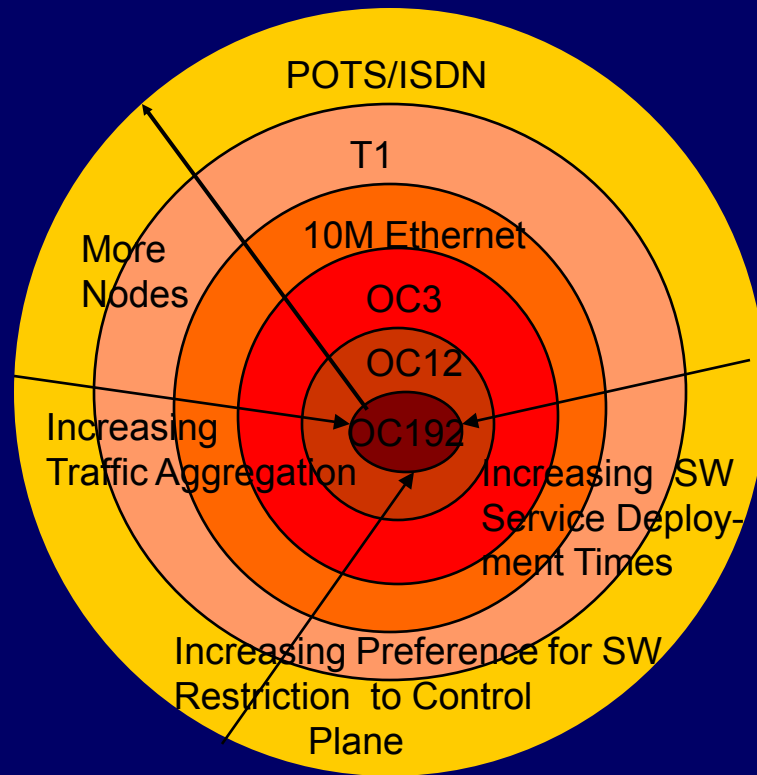
Fiber-coupled processing?

Fiber Optic Input

OE + Framing

64 bit register

CPU

Framing + EO

Fiber Optic Output
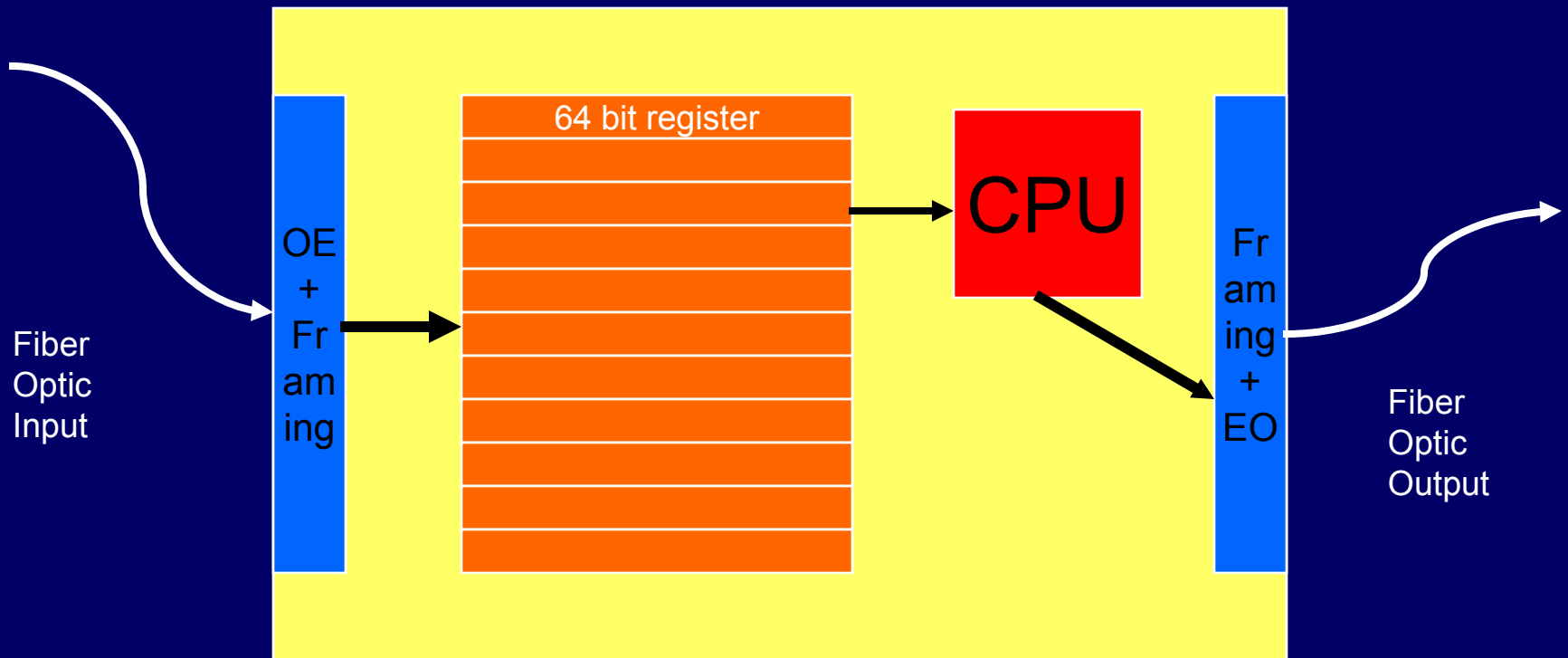
Register-Only Media Processor (ROMP)

The "2020 Vision"

- Is (# people)*(video bit rate) all the bandwidth we will ever need?
- NO! There's a lot going on!
- The "vision" is one of *information fusion*
- The goal is: right information, to right person, at the right time
- Huge challenges in systems design

The basic architecture

☐ Nets and computers improving exponentially. Humans, well…

☐ Active nodes have "delegates"

- select information (watching a million cameras……)
- forward towards you for consumption
- your senses extended into the network

Can we do it?

☐ Active nets are getting there
- architecture being developed
- performance, security, scale all issues
- mature in 2-5 years

☐ We need deployable HCI and AI technologies

☐ Towards the ultimate SPAM filter!

Conclusion

- Today's applications of active networks are incremental, against today's problems
- Tomorrow's problems just taking shape, but people already complaining of information overload with slow nets!
- Active information movement
- Hope to see you there!