



Distributed System Design and Technology Transfer: Hard Lessons Learned

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**Co-Founder, CTA and Member of the Board,
Cadence Design Systems**

Outline

- **Challenges for System Design**
- **The role of Communication-based Design**
- **Platform-Based Design for Communication in Distributed Systems: a Synthesis Approach**
- **Failures in Innovation: a Personal History**

We Live in an Imperfect World!

PAGE 14 – SUNDAY, FEBRUARY 6, 2005 – THE NEW YORK TIMES (by Tim Moran)

What's Bugging the High-Tech Car?

On a hot summer trip to Cape Cod, the Mills family minivan did a peculiar thing. After an hour on the road, it began to bake the children. Mom and Dad were cool and comfortable up front, but heat was blasting into the rear of the van and it could not be turned off.

Fortunately for the Mills children, their father – W. Nathaniel Mills III, an expert on computer networking at I.B.M. – is persistent. When three dealership visits, days of waiting and the cumbersome replacement of mechanical parts failed to fix the problem, he took the van out and drove it until the oven fired up again. Then he rushed to the mechanic to look for a software error.

Additionally, the study found that although errors cannot be removed, more than a "It took two minutes for them to hook up their diagnostic tool and find the fault," said Mr. Mills, senior technical staff member at I.B.M.'s T.J. Watson Research Center in Hawthorne, N.Y. "I can almost see the software code: a sensor was bad."

Indeed, the high-tech comfort system confused the 2001 sending freezing loyal van up, third billion, c

MOTOR TREND

NHTSA To Probe Reports Of Sudden Engine Stalls In Prius Hybrids

The National Highway Traffic Safety Administration said yesterday it is investigating reports that a software problem can cause the engine of Toyota's Prius hybrid to stall without warning at highway speeds. No accidents have been reported thus far.

NHTSA has received 33 reports of stalling in Prius cars from model years 2004 and 2005, according to the agency's initial report. More than 85 percent of the cars that stalled did so at speeds between 35 and 65 miles per hour.



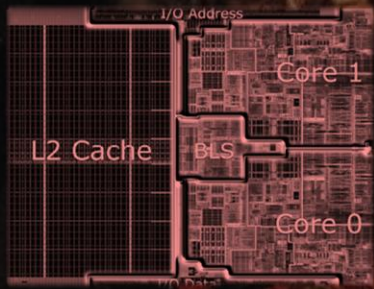
GSRC Vision 1998

ASV: It's all about
Communication!

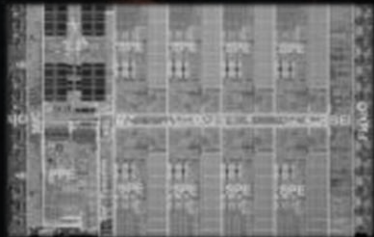
ARN: It's all
about
Concurrency!

EAL: Actually, it's all about
Heterogeneity!

Concurrency, Communication, Heterogeneity

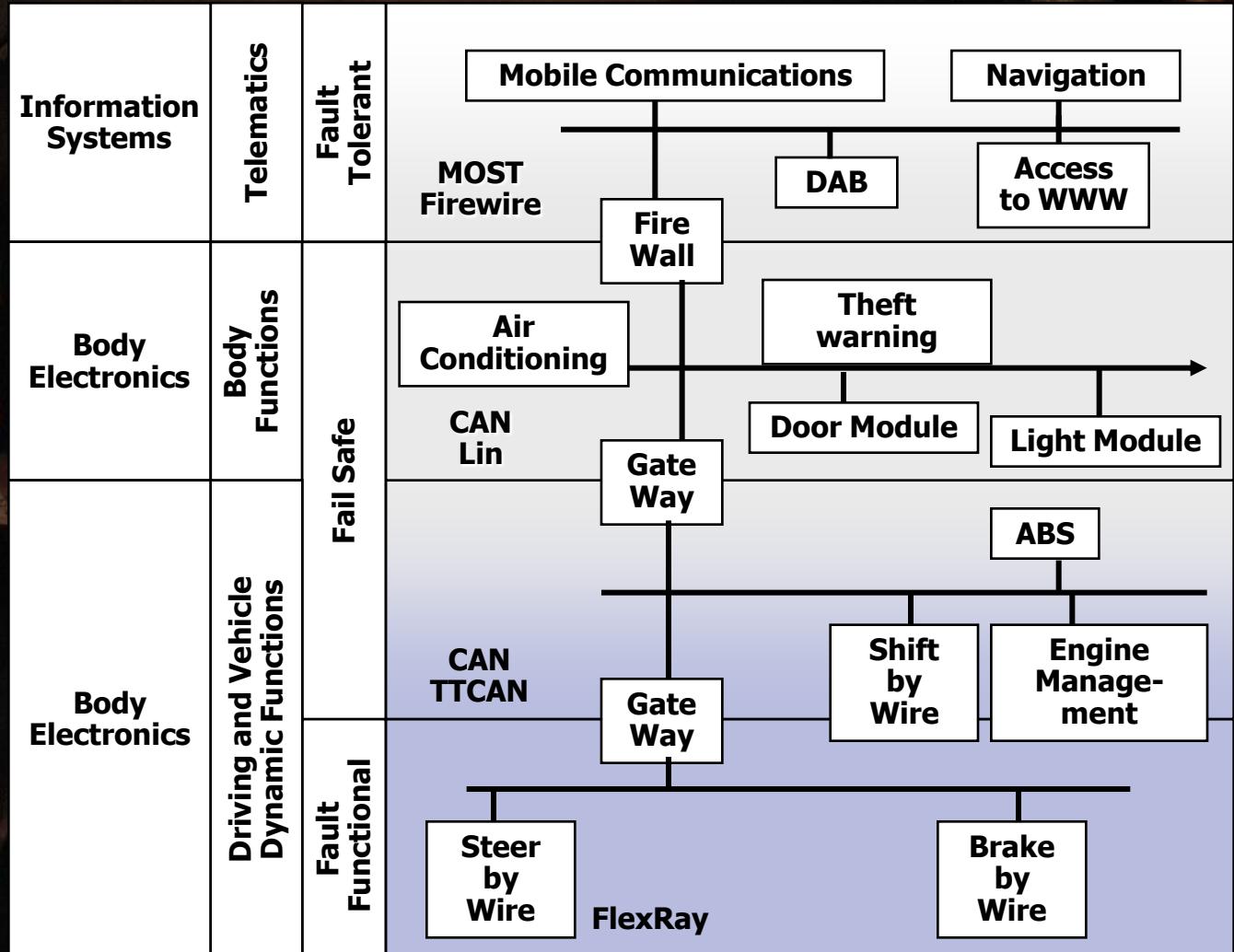


Intel KEROM dual core
ISSCC 07, 290M trans.



IBM/Sony Cell
ISSCC 05, 235M trans.

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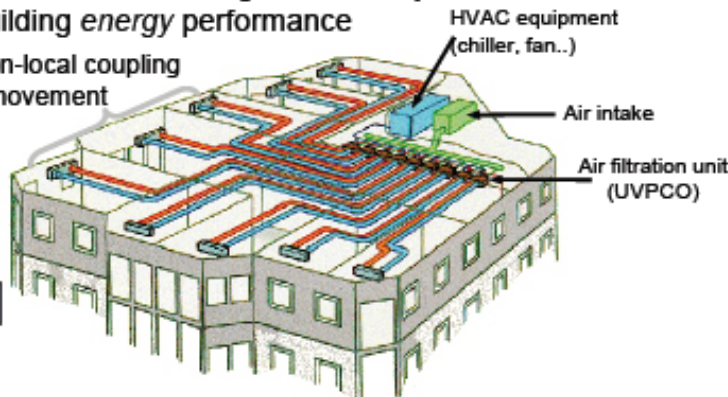


HVAC: High Performance Buildings

*Objectives: Efficient energy utilization and occupant comfort for normal building operation
Robust response to health and safety threats and events*

Energy & mass balances govern steady-state building energy performance

"Slow" non-local coupling
from air movement
system



- Large, spatially distributed system

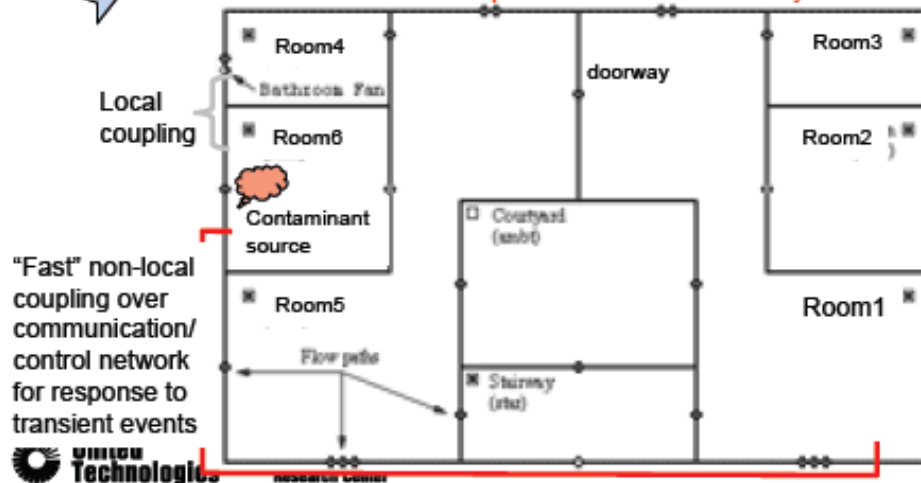
- Interconnected system

- Room neighborhood scale
- Building floor scale
- Whole building scale

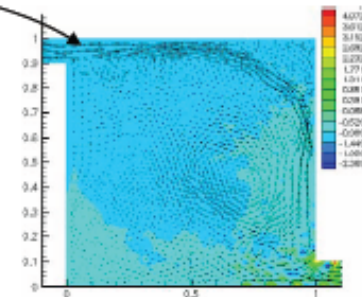
- Multi-scale dynamic system & its control

- Wide time scale separation
- "Close" coupling leading to dynamic constraints between network and physical system

Multi-zone, steady/quasi-steady behavior at intermediate scales
relevant to occupant comfort and safety

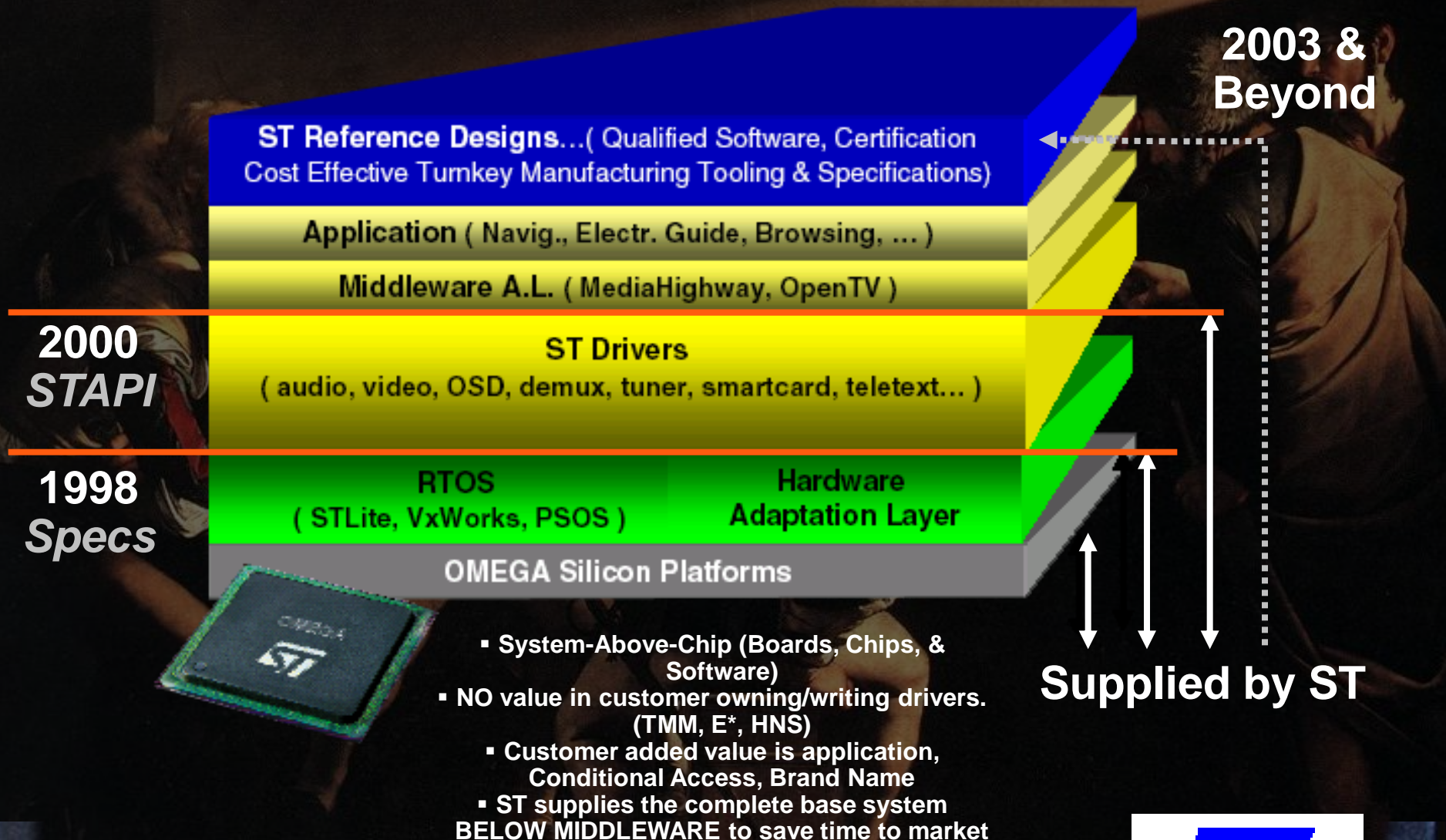


"Fast" non-local
coupling over
communication/
control network
for response to
transient events



Spatiotemporal airflow dynamics at room
scale relevant to safe building
environment

Challenge: Platforms and Software Content



Challenge: Design Chain Integration

Automotive Industry

Automakers



- 2005 Revenue \$1.1T
- CAGR 2.8% (2004-2010)

Tier 1 Suppliers



90%+ of revenue from automotive

- 2004 Revenue ~\$200B
- CAGR 5.4% (2004-2010)

IC Vendors



~15% of revenue from automotive

- 2005 revenue \$17.4B
- CAGR 10% (2004-2010)

Source: Public financials, Gartner 2005

Copyright: A. Sangiovanni-Vincentelli

Challenge summary

Yesterday	Features (can you do it?)
Today	Cost (are you cheaper?)
Tomorrow	Integration (but can you also...?)

Industry will move towards robust architectures which can:

▶ **create a system by just interconnecting modules**

▶ **mix-and-match components from different vendors**

▶ **avoid costly system-level simulations**

The Integration Nightmare

Specification:



P. Picasso "Femme se coiffant" 1940

The Integration Nightmare

Implementation:



P. Picasso "Femme se coiffant" 1940

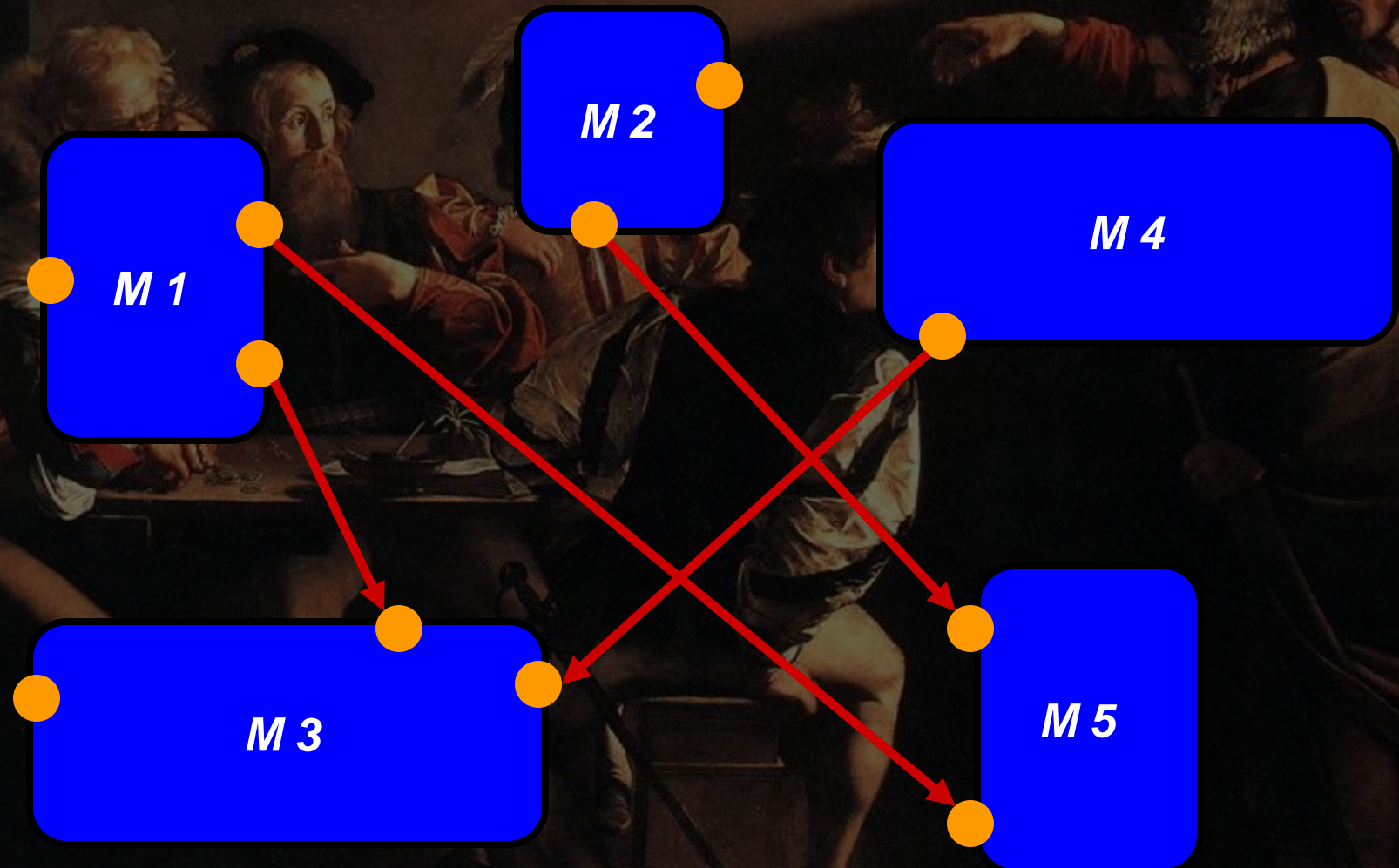
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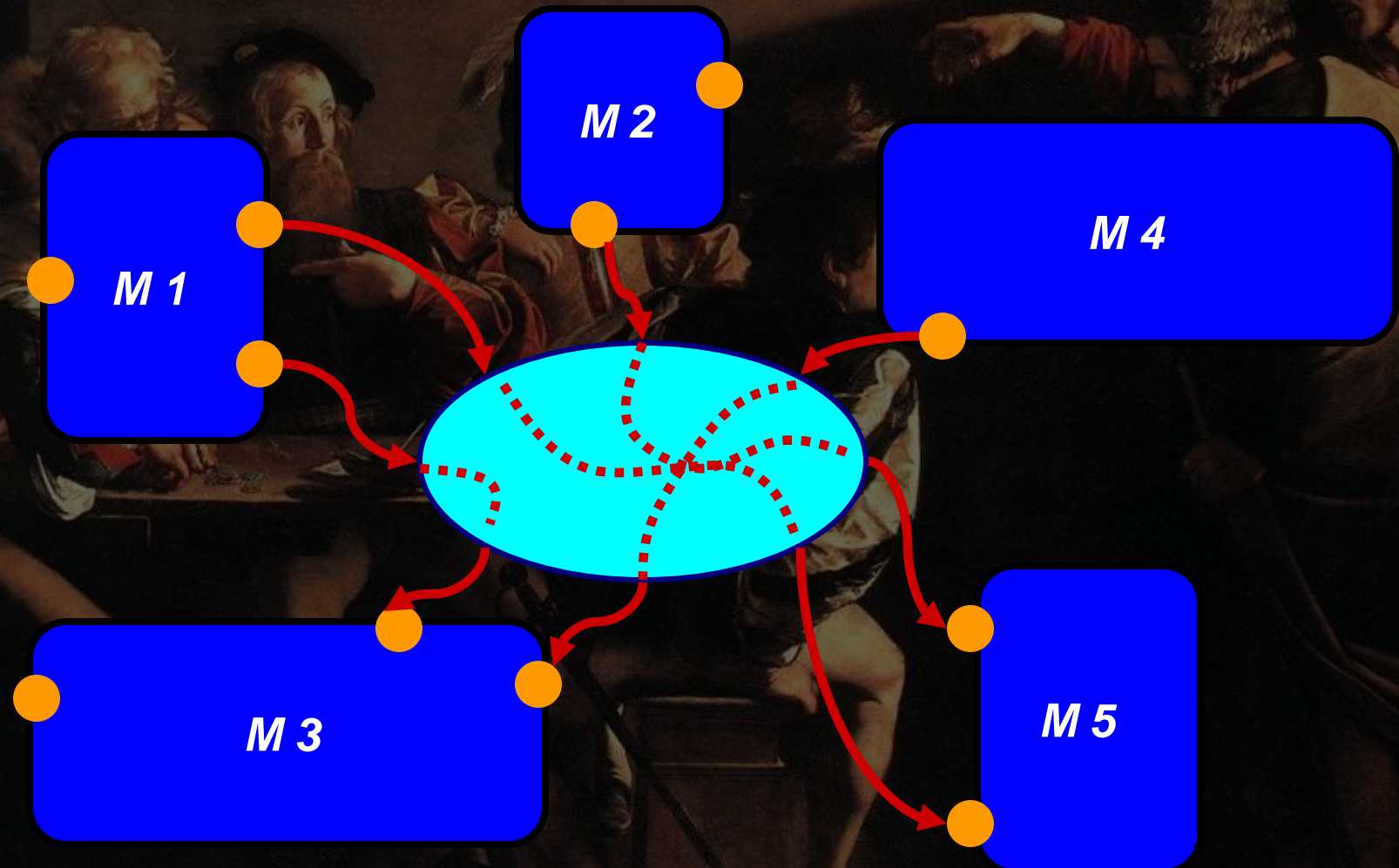
Basic Goals

- Identify precisely and formally the concept of *communication*, its level of *abstraction* and of the corresponding models of computation.
- New theories to combine different models of computation
- Determine a set of properties that characterizes each level of abstraction.

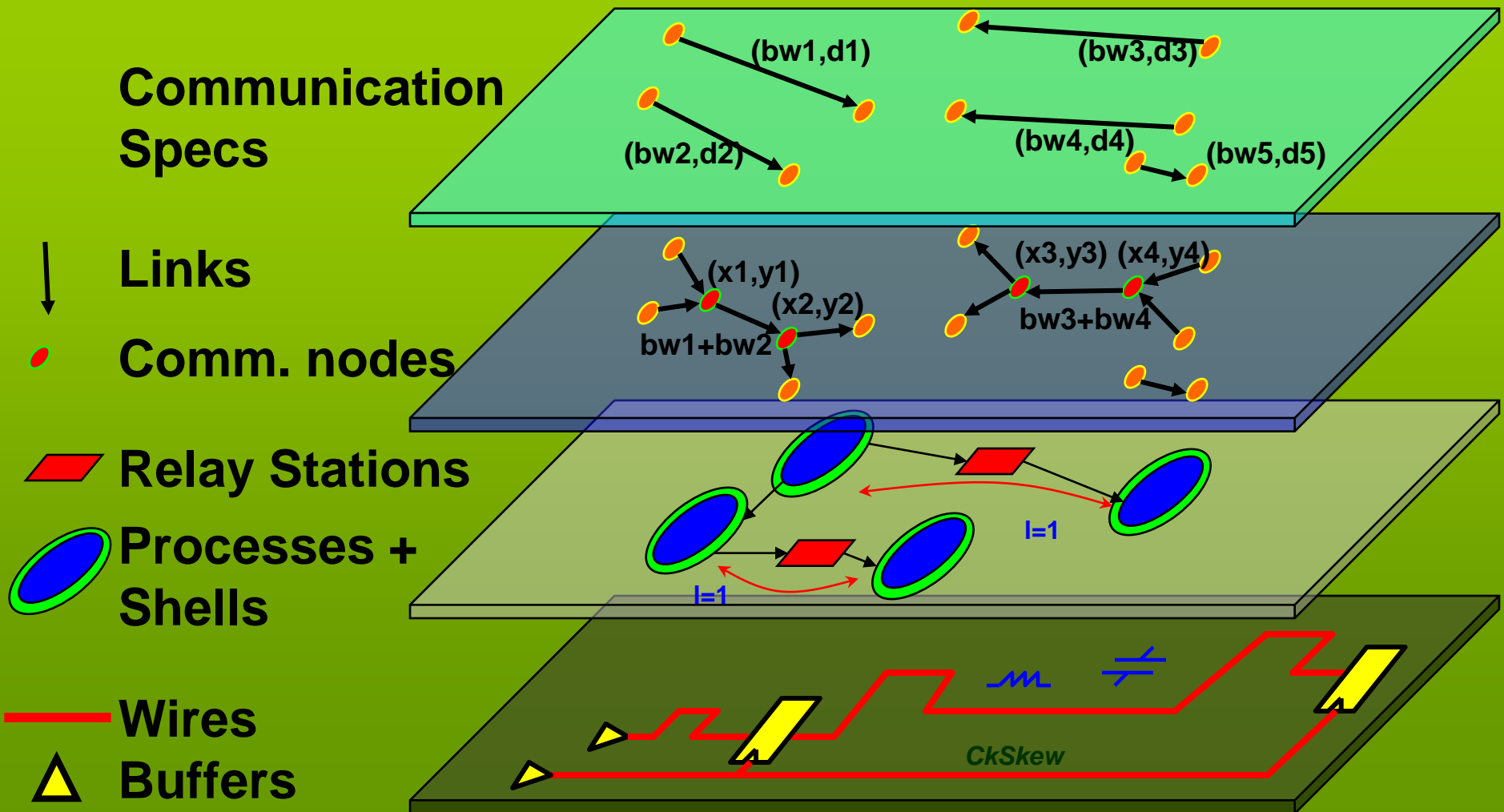
NOC Design



What's the Problem?



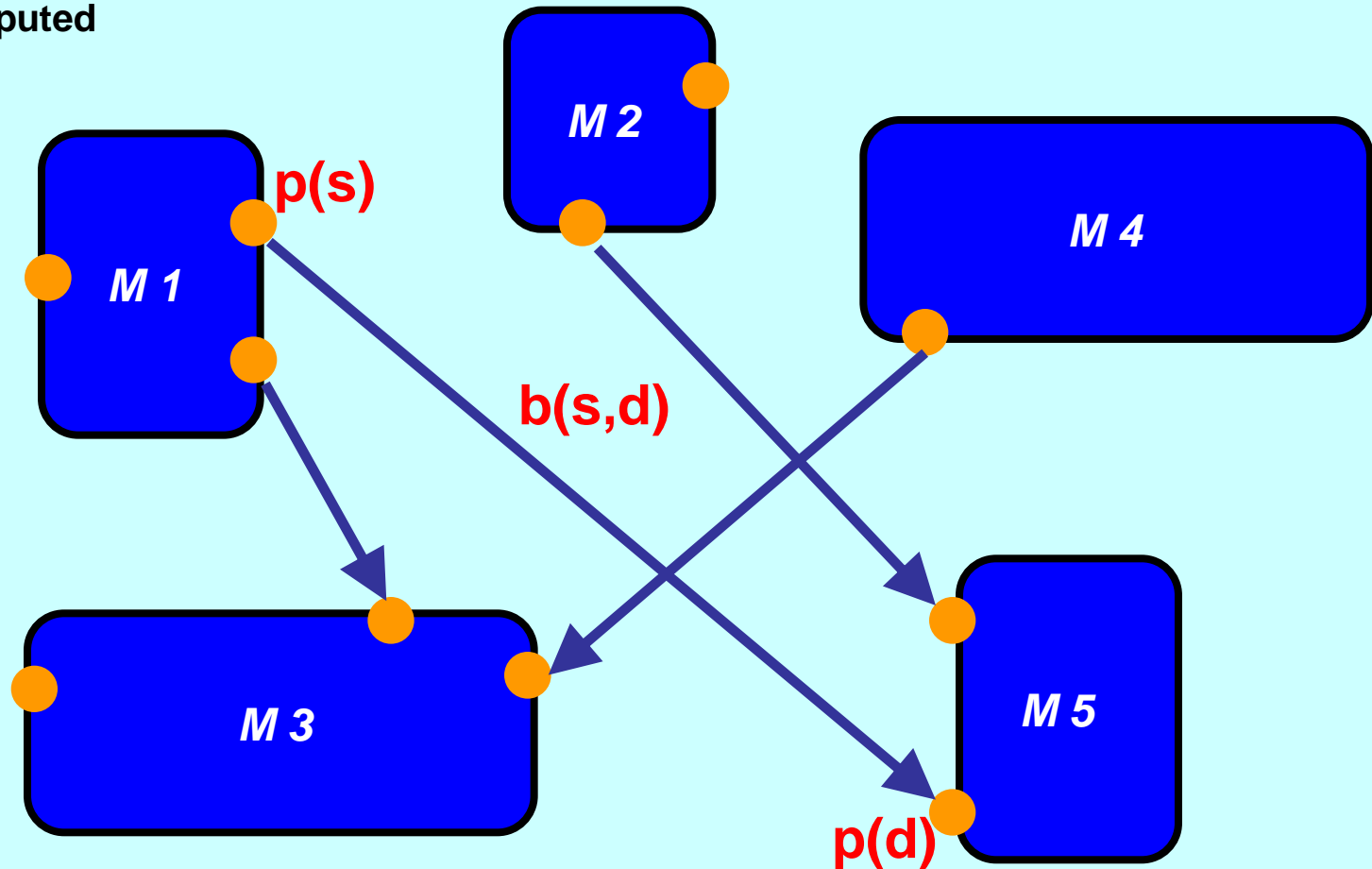
Communication Synthesis Platform Stack



Point-to-Point Specification

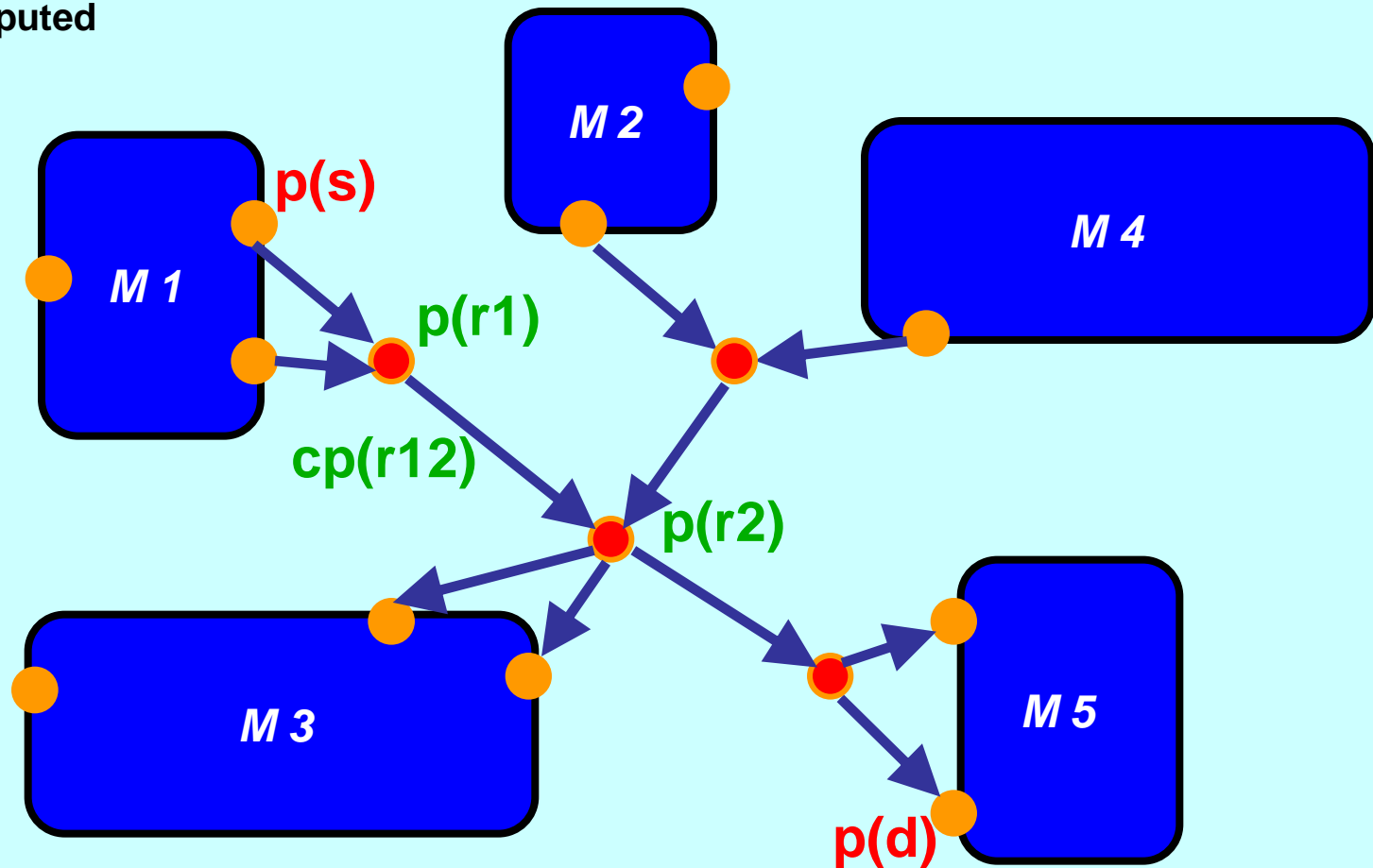
 Given

 Computed



Network Topology Implementation

— Given
— Computed

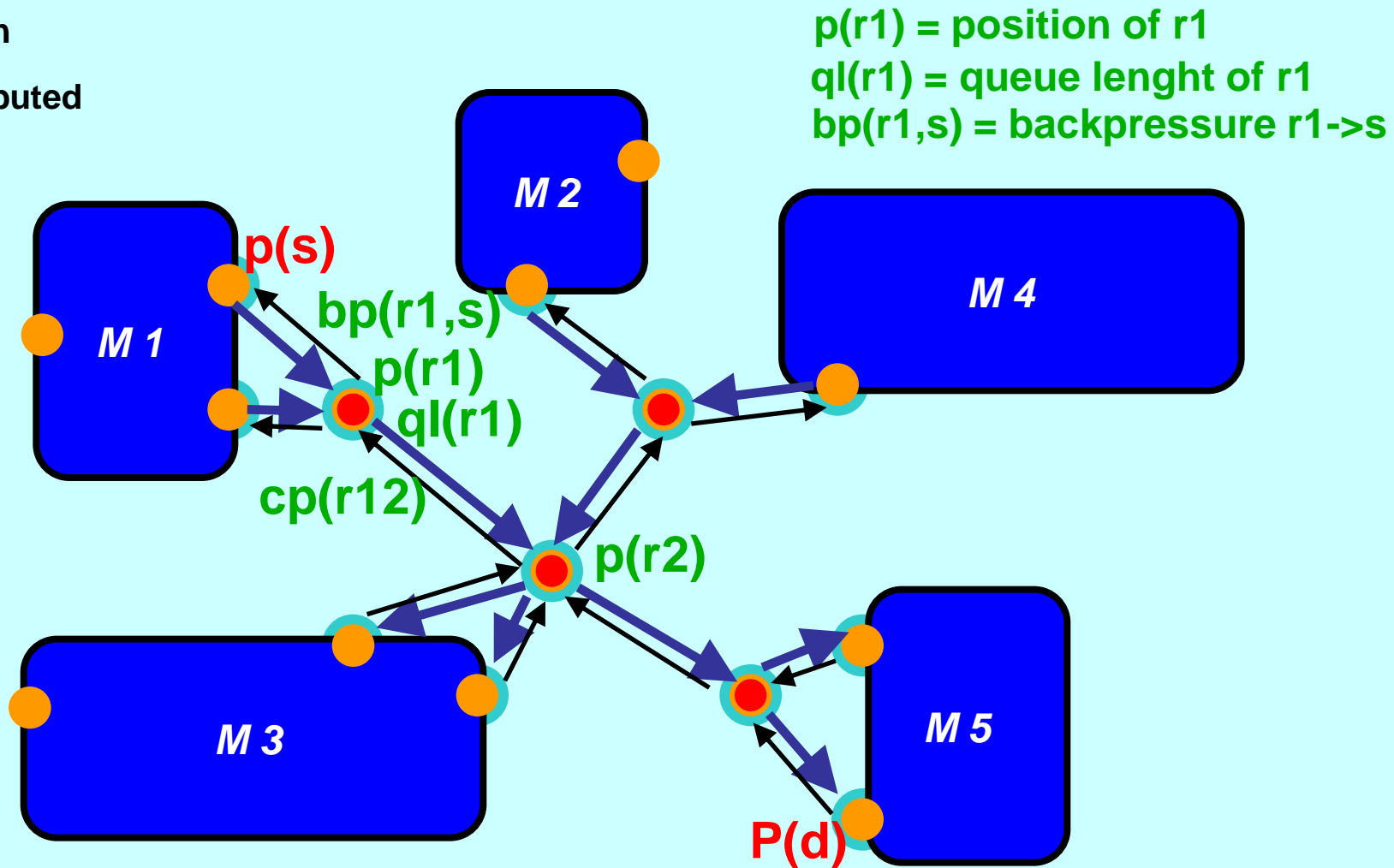


$cp(r12)$ = capacity of link $r1 \rightarrow r2$

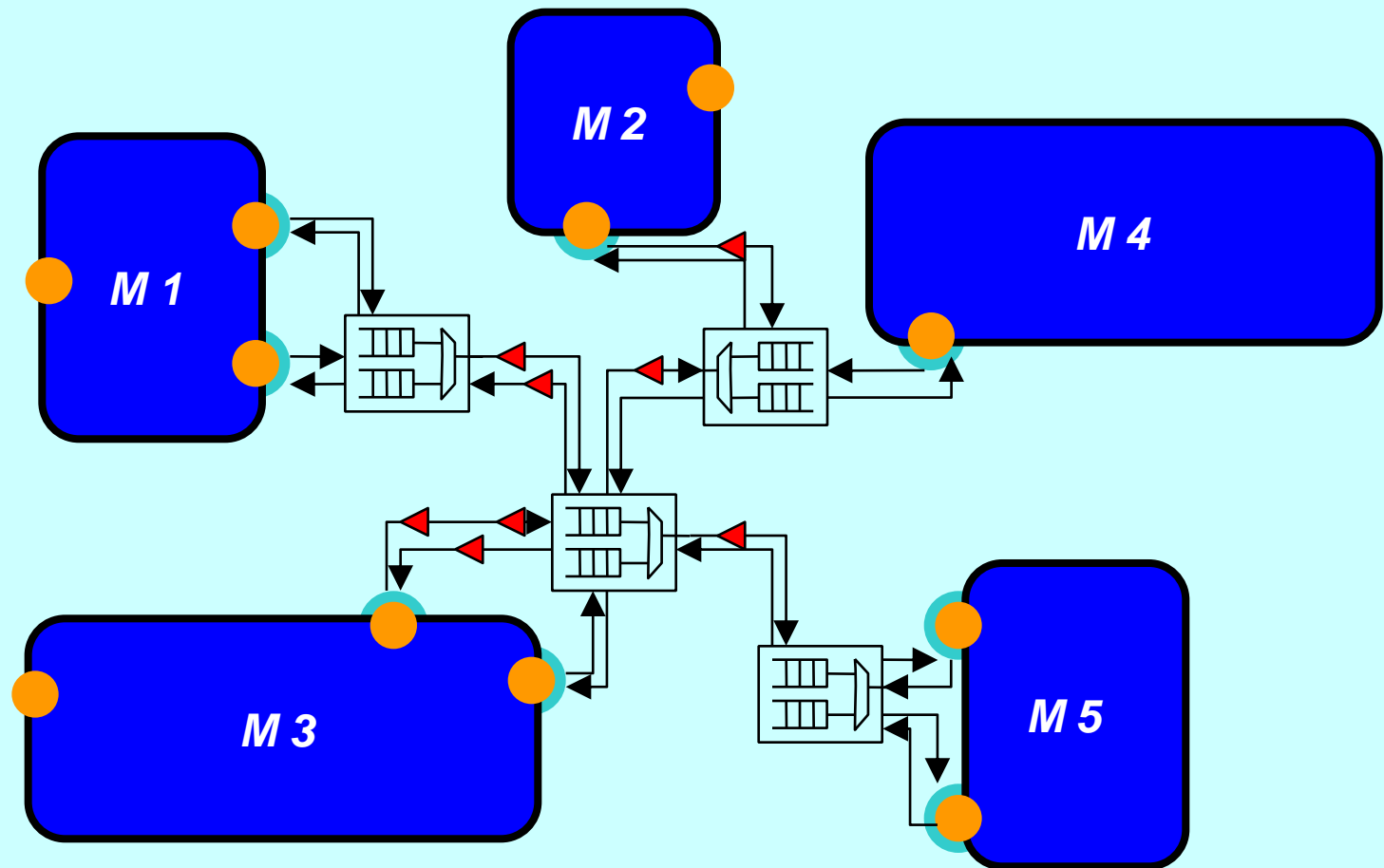
Protocol Implementation

— Given

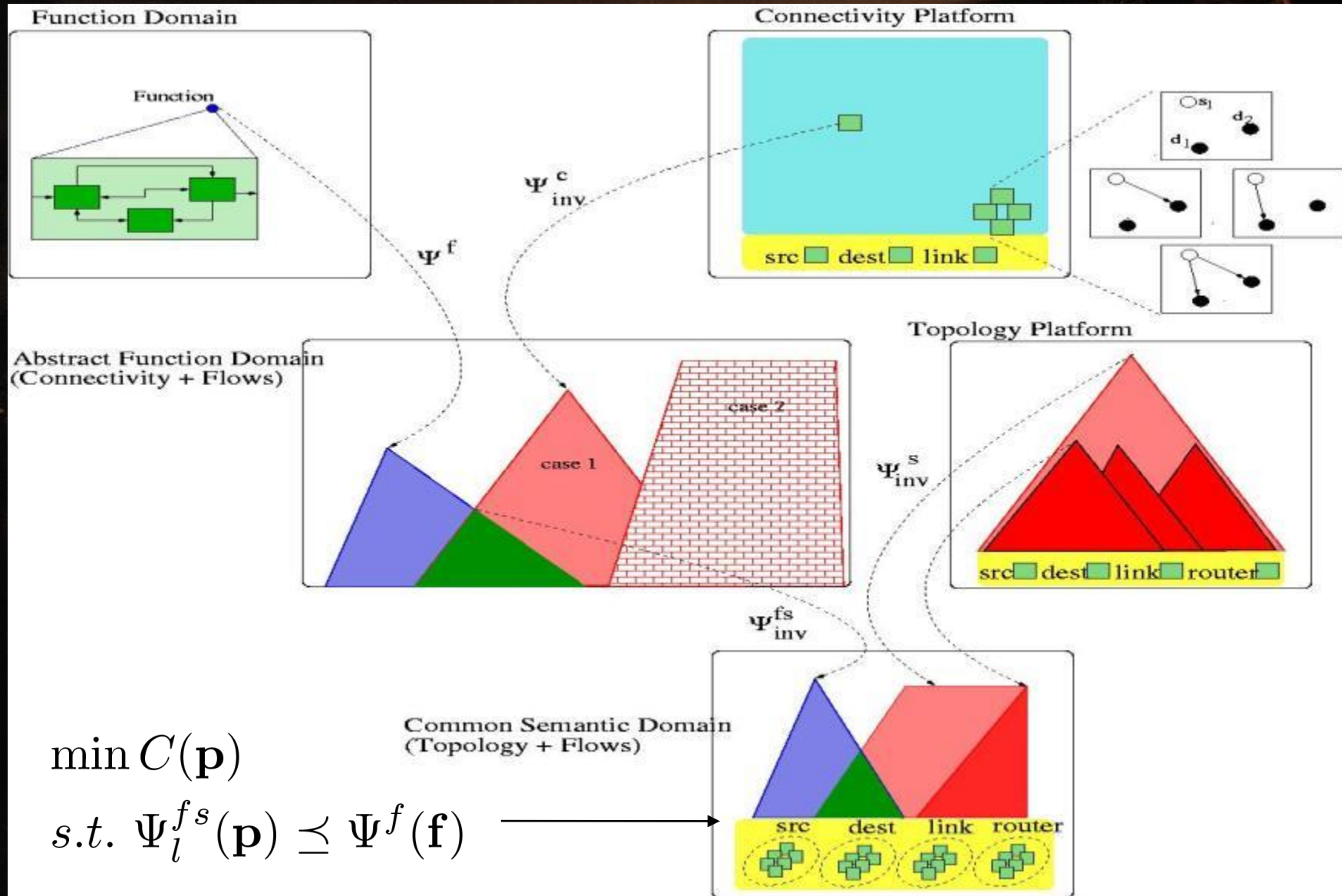
— Computed



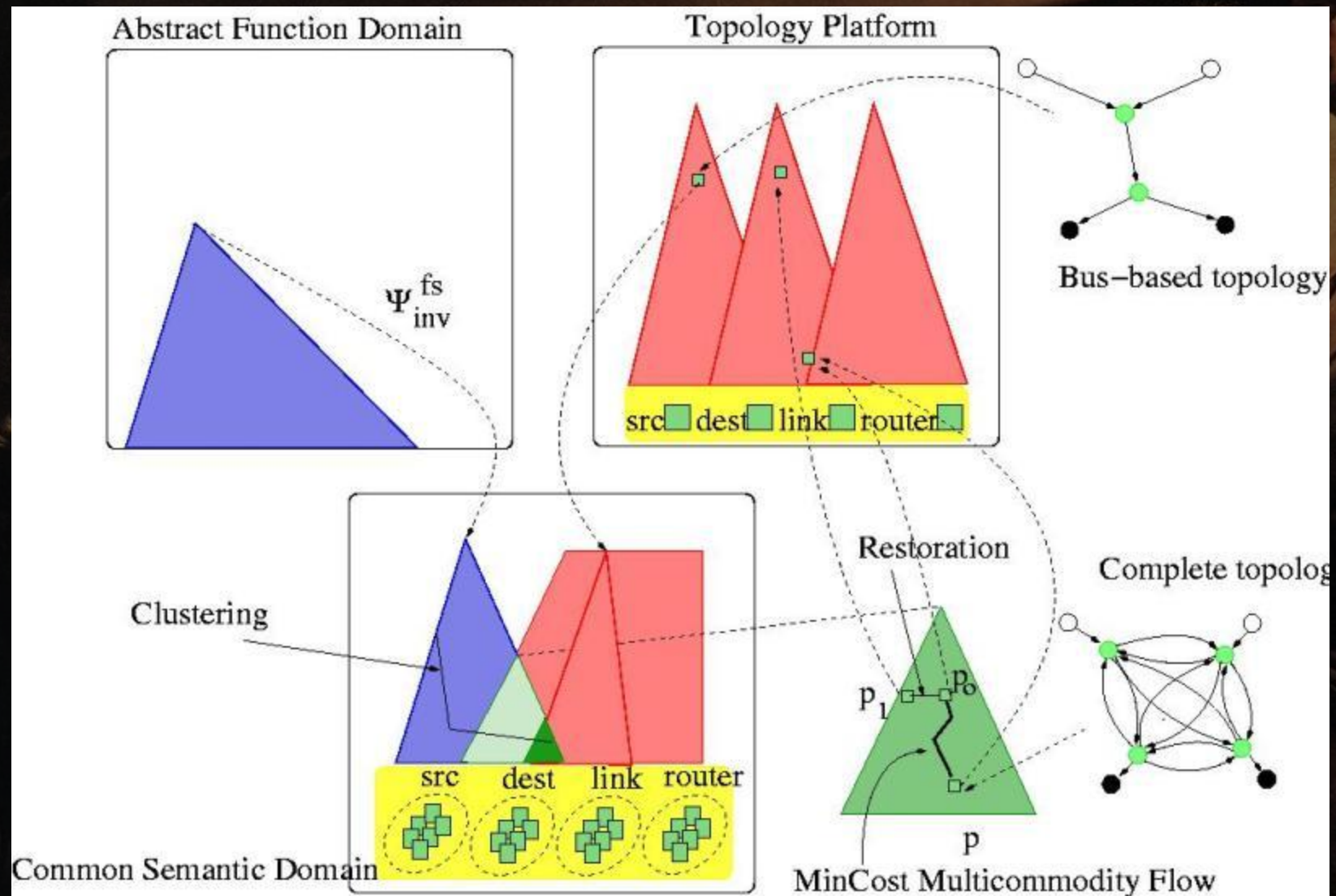
Physical Implementation



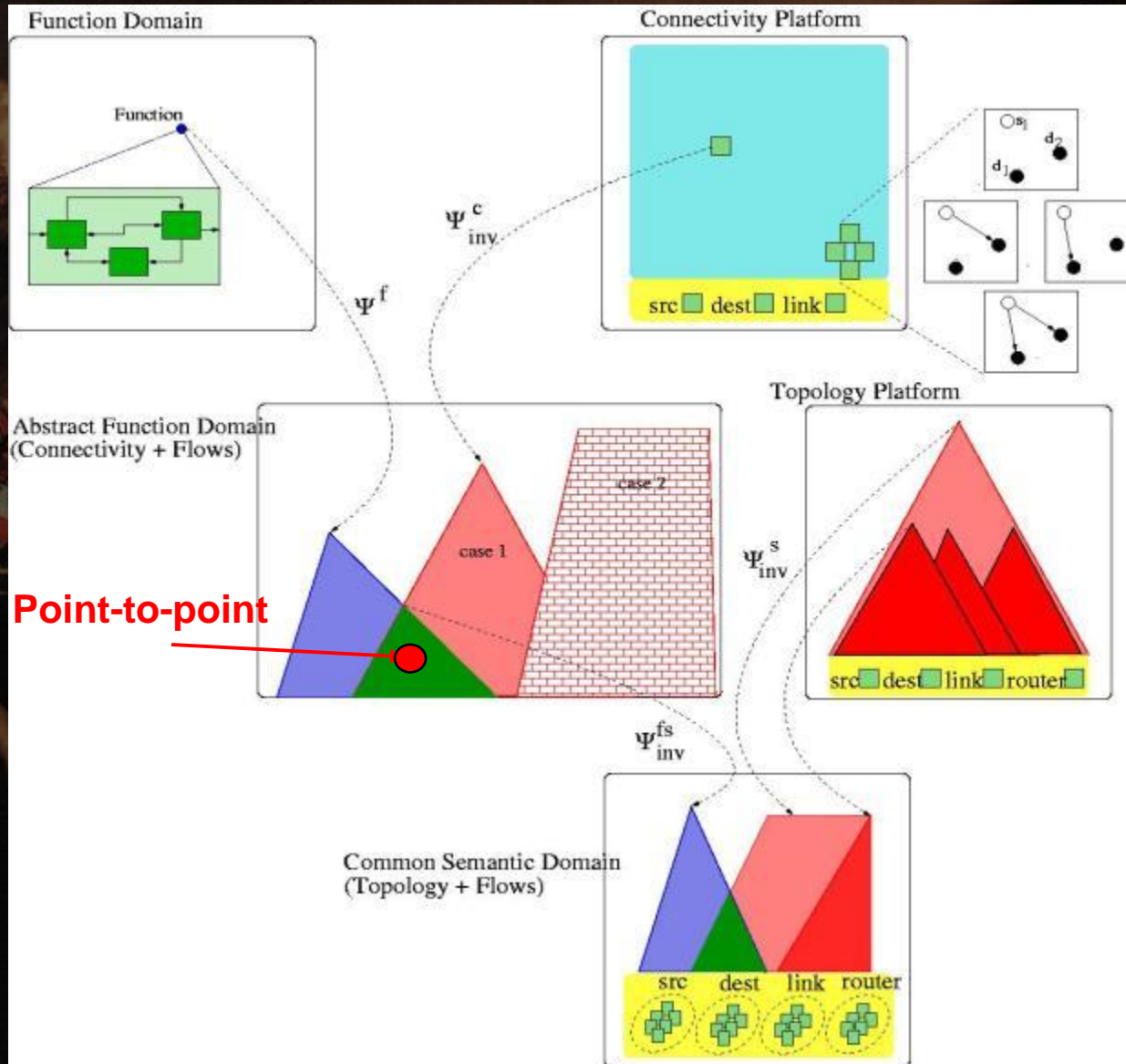
Platform-based design: Communication synthesis



Synthesis of network topology



Comparison



Outline

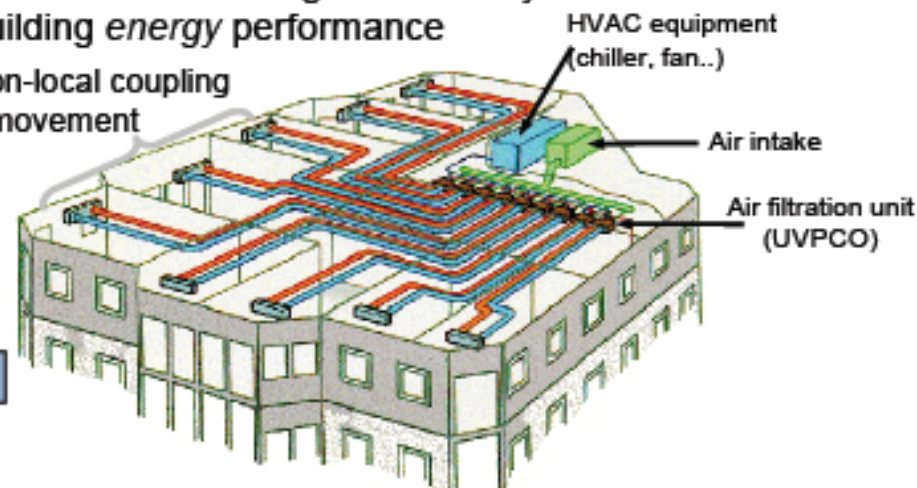
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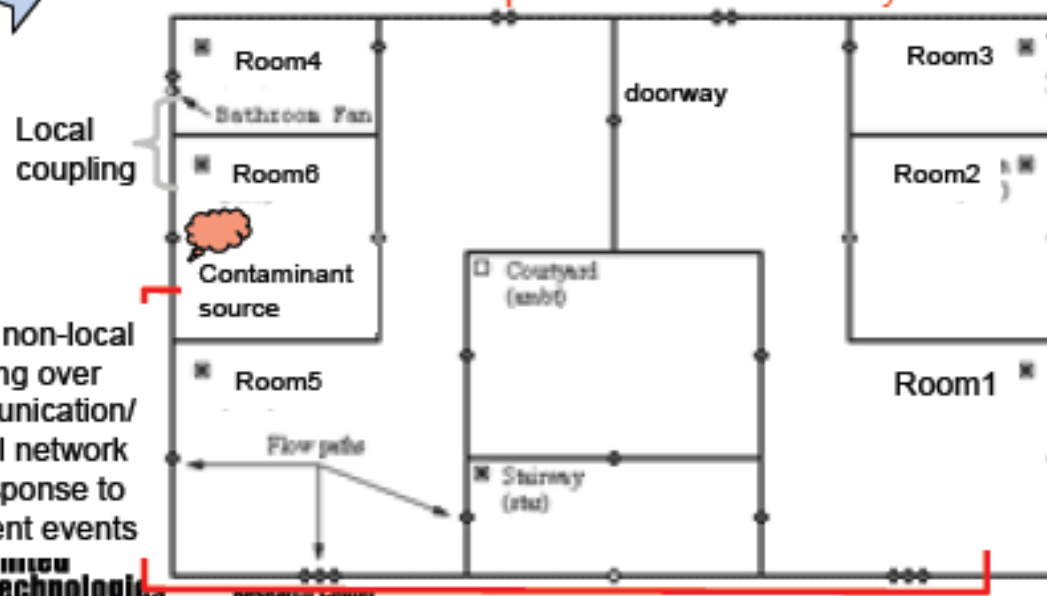
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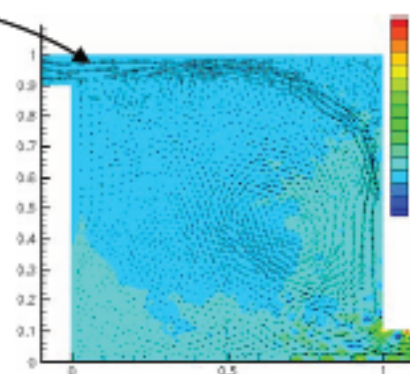
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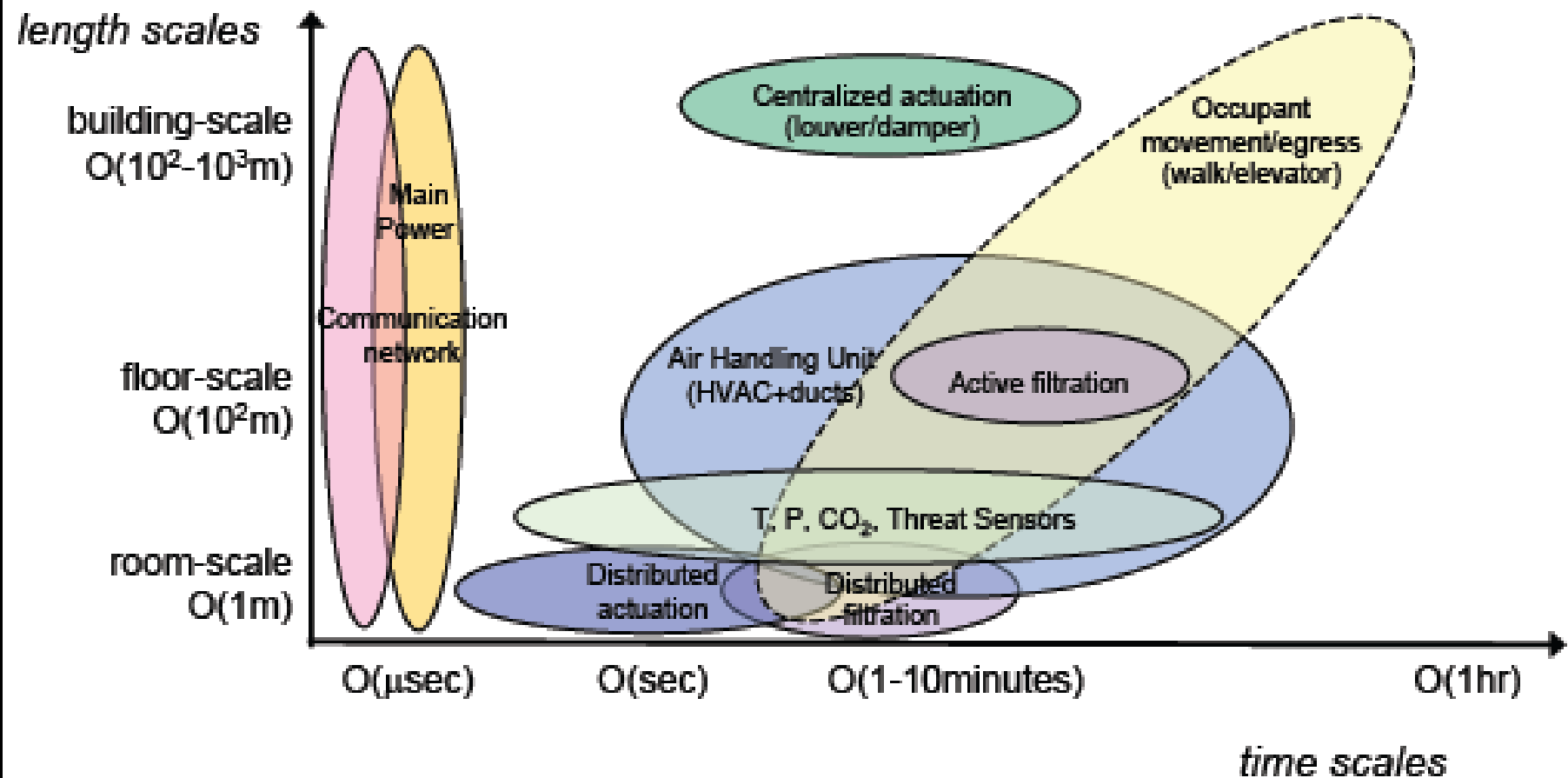
"Fast" non-local coupling over communication/control network for response to transient events



Spatiotemporal airflow dynamics at room scale relevant to safe building environment

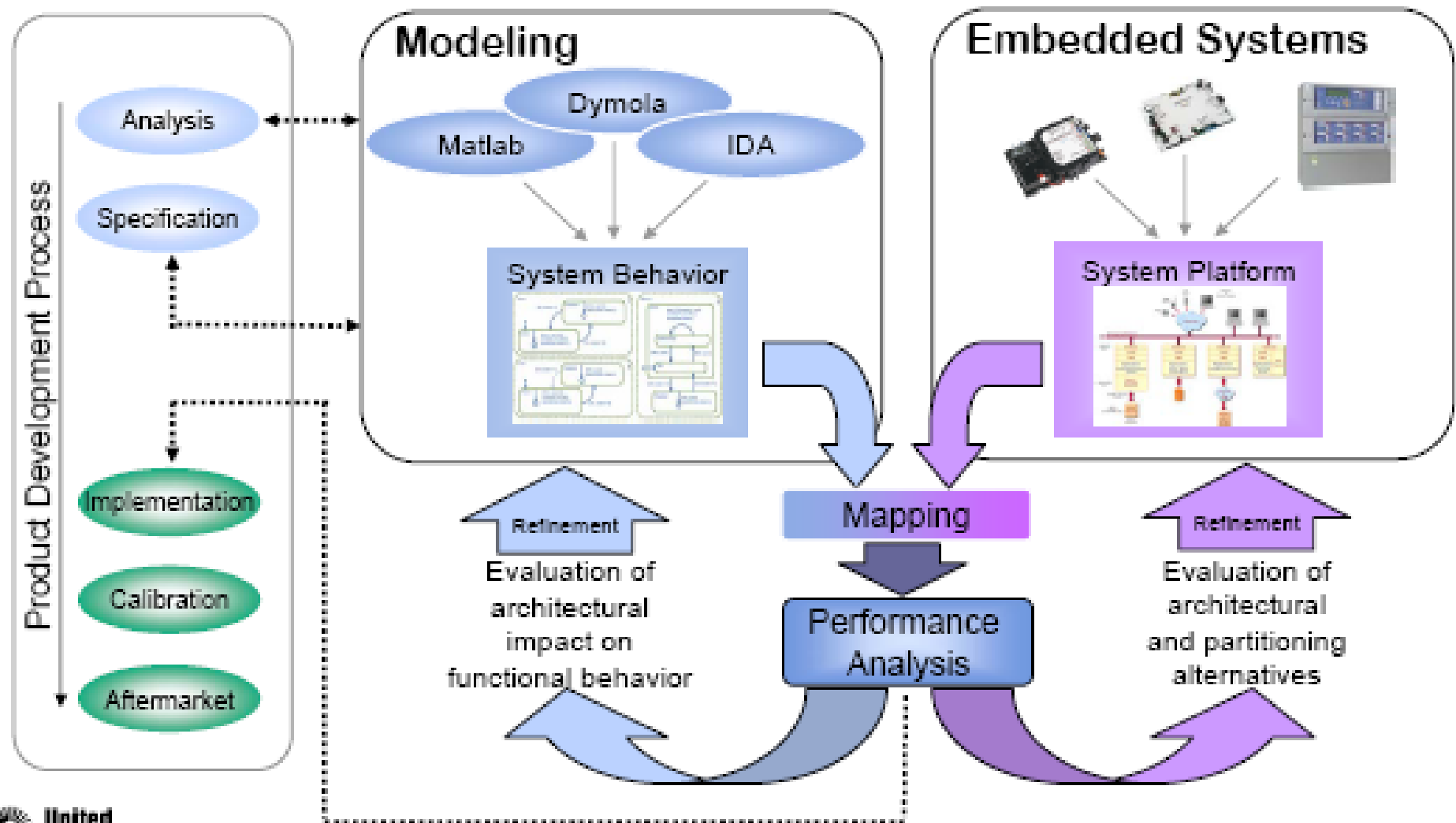
Building System Physics

Dynamics at multiple spatial & temporal scales must be addressed

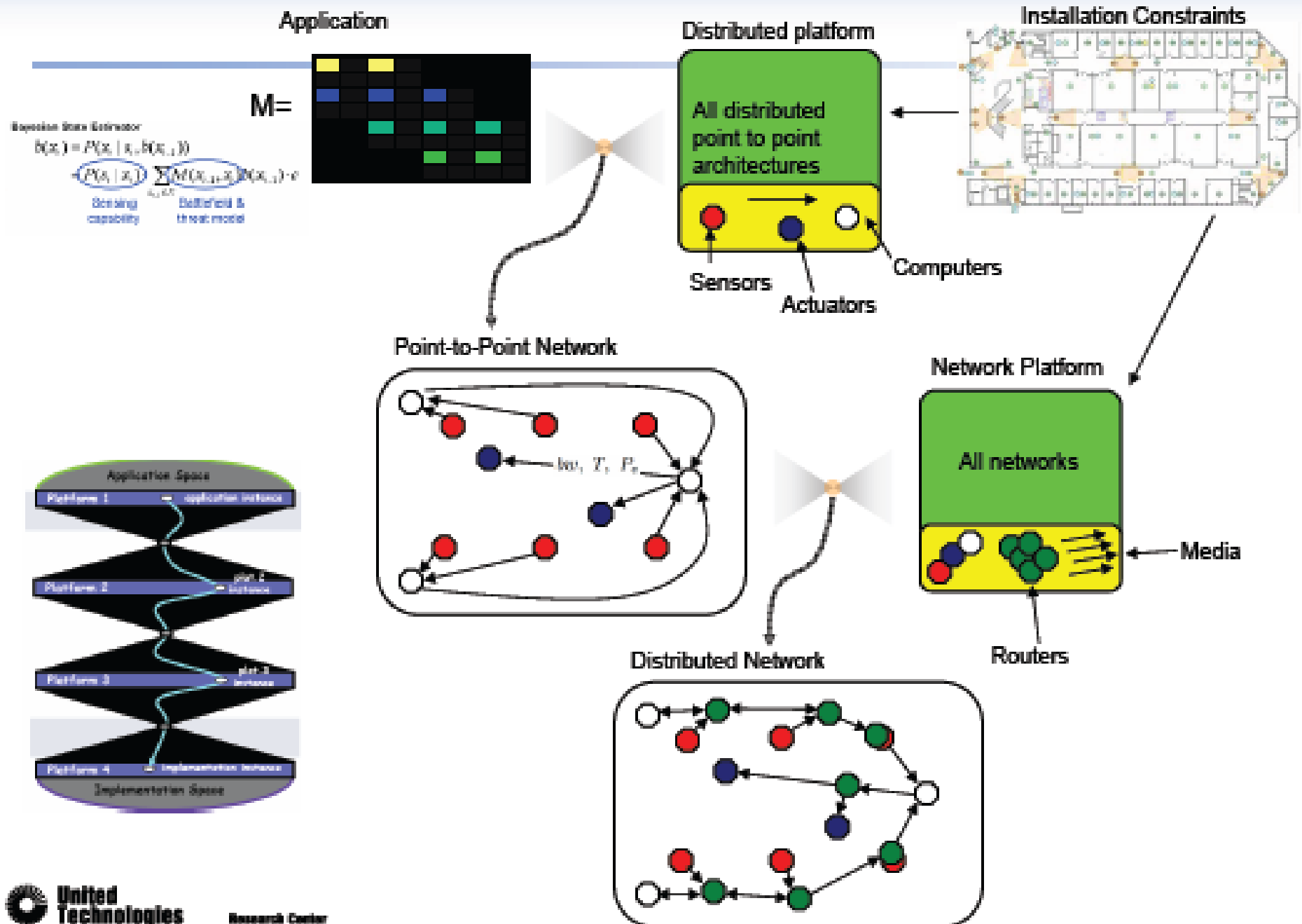


Design Tools: Platform-Based Design

Adopt to networked cyber/physical security systems: fire and HVAC control



Platform-Based Design for Dynamic Networks



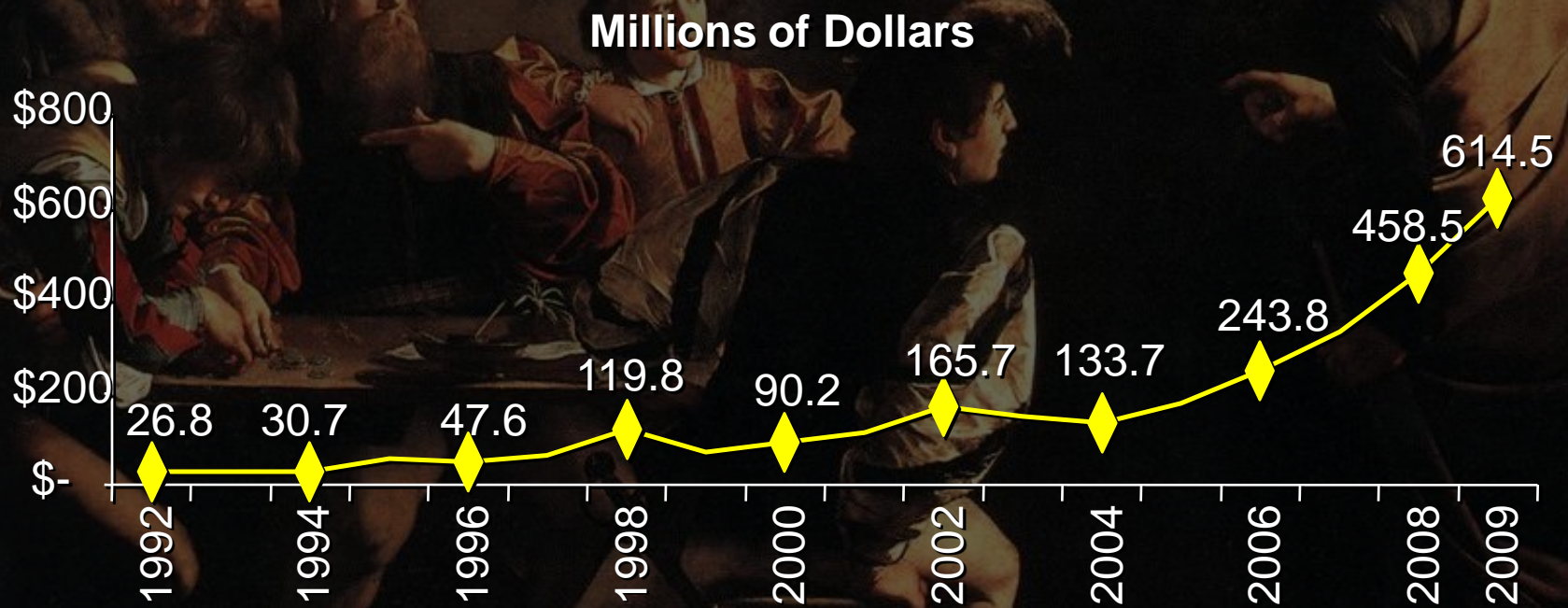
Putting it all together....

- We need an integration platform
 - To deal with heterogeneity:
 - Where we can deal with Hardware and Software
 - Where we can mix digital and analog
 - Where we can assemble internal and external IPs
 - Where we can work at different levels of abstraction
 - To handle the design chain
 - To support integration
 - e.g. tool integration
 - e.g. IP integration
- The integration platform must subsume the traditional design flow, rather than displacing it

Outline

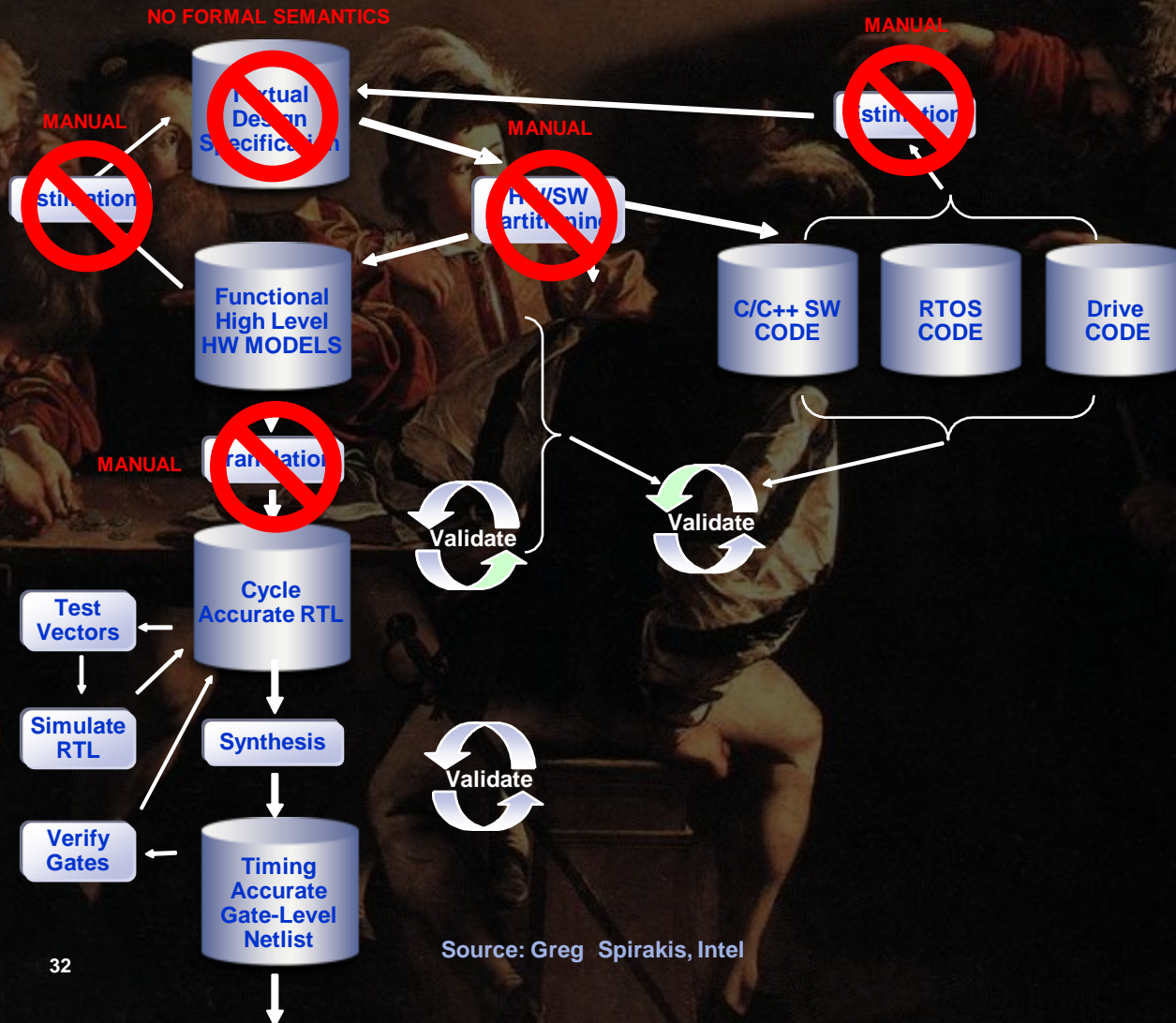
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ESL History



Design Process Transformation in Chip Design

Embedded System Design Gaps



How to make Innovation work

- EDA companies have not been successful in internal innovation
- Acquisitions may not be the best **sustainable** technology source
- What are the root causes of the disease?
- The problem is VERY complex

Distillation

REAL PROBLEMS:

1. Large all encompassing projects have almost probability 1 of failure: “bureaucracy” stifle any innovation
2. Identity, Ownership, Leadership and Accountability (Analog Division)
3. It is not enough to have small incubators, start-ups inside or outside: the crux of innovation is in the process
4. The critical step is from conception to productization



The Present



- **Electronic Industry facing an array of complex problems from design to manufacturing involving complexity, power, reliability, reconfigurability, integration, embedded software**
- **Design Methods and Tools lacking: active research field**
- **EDA vendors have to extend their reach into the system space**
- **Innovation of this magnitude is difficult to achieve**
- **Investment needed from Government, IC and System industry otherwise the situation is bound to become more critical. Not an issue of languages or point tools!!**
- **A Glimpse at the Future**

- 
- Lustre and Scade
 - Airbus LTTA
 - Matra subway systems

WITHOUT COMPROMISING SCIENCE

System Design:
FROM *Art* TO Science

Paul Caspi: a view from a friend!

