Standards for NoC: What can we gain?

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What Kind of Standards

- Informal Standards are a set of assumptions shared and agreed upon in a community
- Industrial standards are set by companies that guess right
- Formal standards (IEEE, ISO, ...) are usually preceded by an informal consensus
Standards vs. Creativity
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Standardizing Interfaces and Protocols

- Pins
- Data link
- Transactions
- End-to-end communication services
- Functionality + performance contracts
Standardizing Interfaces and Protocols

We gain:

- Reuse of IPs
- Reuse or verification
- Outsourcing and specialization
- Separation of
  - Physical design issues
  - Communication design
  - Component design
  - Verification
  - System design

- Pins
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- Transactions
- End-to-end communication services
- Functionality + performance contracts

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Standardization of Design Methodologies

- Reuse of concepts
- Methodologies
- Methods
- Design languages
- Tools

Reuse, separation of concerns and specialization are driving forces
We can build on top of standards

Assuming we have standard communication services, we build on top of them:
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- Design tools:
  - System performance analysis
  - Formal communication verification
  - Allocation, mapping, and scheduling
  - etc.
We can build on top of standards

Assuming we have standard communication services, we build on top of them:

- **Design tools:**
  - System performance analysis
  - Formal communication verification
  - Allocation, mapping, and scheduling
  - etc.

- **New services:**
  - Dynamic resource allocation and management
  - Dynamic power management
  - On-line testing and diagnostics
  - Off-chip communication services
  - etc.
Standardization of Performance Metrics
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- Benchmark applications and Stochastic micro-benchmarks
Standardization of Performance Metrics

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- Packet level and Transaction level
Standardization of Performance Metrics

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- Packet level and Transaction level
- Unloaded and Loaded case
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- Benchmark applications and Stochastic micro-benchmarks
- Packet level and Transaction level
- Unloaded and Loaded case
- Various temporal and Spatial distributions of traffic
- Best effort and Guaranty services
- Sizes between 16 and 200 nodes
# Unloaded Case

<table>
<thead>
<tr>
<th></th>
<th>Delay</th>
<th>Bandwidth</th>
<th>Energy</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Read 16/32/64b</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Write 16/32/64b</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Open Stream</td>
<td></td>
<td></td>
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<tr>
<td>Close Stream</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Message 1/4/16/32B</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
## Loaded Case

<table>
<thead>
<tr>
<th></th>
<th>$D_1$</th>
<th>$D_2$</th>
<th>$D_3$</th>
<th>$D_n$</th>
<th>Sustained bandwidth</th>
<th>Energy /byte</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet Transaction</td>
<td></td>
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</tr>
<tr>
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</tbody>
</table>

1 \(-10^{-i}\) of all packets $p$: $\frac{\text{delay}(p)}{\text{mindelay}(p)} \leq D_i$

$D_1 : 90\%$, $D_2 : 99\%$, $D_3 : 99.9\%$, $D_n : 100\%$

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Temporal Distributions

- Uniform
- Bursty traffic according to the B-Model: $B_{0.2}$, $B_{0.3}$, $B_{0.4}$
Spatial Patterns

- Uniform
- Uniform with locality
- Bit Rotate
- Bit Complement
- Hot Spot
- Fork-Join Pipeline

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Size

Number of nodes: 8, 16, 25, 40, 60, 80, 100, 150, 200
Data Points for Stochastic Micro Benchmarks

- Temporal distribution: $4 \times$
- Spatial patterns: $12 \times$
- Unloaded case: $((14 \times 4) +$
- Loaded case: $((14 \times 6)) \times$
- Size: $9 = 60480$
$D_1$ versus network size in Nostrum

![Graph showing normalized delay versus number of nodes for different uniform distributions with varying percentages.](image-url)
$D_2$ versus network size in Nostrum

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$D_3$ versus network size in Nostrum

![Graph showing $D_3$ versus network size in Nostrum with different load configurations.](image-url)
$D_n$ versus network size in Nostrum

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Summary

- Standards are crucial and complementary to innovative research
- Let’s standardize performance metrics