Is there hope for GALS in the future?
Locally Synchronous and Globally ... ●

Advantages of GALS Systems in a Nutshell ●

Classical GALS Myths (area/speed/power) ●

GALS at ETH Zurich ●
Different GALS implementations

<table>
<thead>
<tr>
<th>Data Synchronization:</th>
<th>Pausable Clocks</th>
<th>Synchronizers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2-phase</td>
<td>4-phase</td>
</tr>
<tr>
<td>Handshake:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signalling:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bundled Data:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>m-of-n</td>
<td></td>
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</tbody>
</table>

They are suitable for systems with:
- Coarse granularity
- Infrequent and/or bursty data transfer between modules

GALS systems may differ in:
- Coarse granularity
- Infrequent and/or bursty data transfer between modules
GALS Myths: Faster

- Where average case performance differs much from worst-case performance, GALS systems may be faster.

  * All modules can run at their optimal frequency rather than a system dictated compromise frequency.
  * System can be designed in a way to exhibit average case performance.
Where average case performance differs much from worst-case performance

- Slowest operation might be on the critical path

- GALS systems have communication overhead

- System can be designed in a way to exhibit average case performance rather than a system dictated compromise frequency

- All modules can run at their optimal frequency

- GALS systems may be faster

GALS Myths: Faster
Some blocks can be made smaller due to less stringent timing requirements. Several modules can be spared:

- (power down modules, central clock generators, system wide clock buffers)
- Several modules can be spared:
- Counter-part:

A GALS system might turn out to be smaller than a synchronous
GALS Myths: Smaller

- A GALS system might turn out to be smaller than a synchronous counter-part.

  ∗ Several modules can be spared: (power down modules, central clock generators, system wide clock buffers)

  ∗ Some blocks can be made smaller due to less stringent timing requirements

  but...

  ∗ GALS has area overhead (not much but still 2-10%)
GALS Myths:

Low Power

- GALS has the potential to save power
- Inactive modules do not receive clock saving dynamic power
- Supply voltage can be scaled dynamically for individual modules
GALS Myths: Low Power

- GALS has the potential to save power
  - Inactive modules do not receive clock saving dynamic power
  - Supply voltage can be scaled dynamically for individual modules

  but

- Synchronous methods (clock gating) may achieve similar savings
- Modern technologies do not offer too much margin for scaling
GALS will definitely not deliver 10x improvements.

- GALS are not generally smaller, faster or consume less power.
- However, they are not far behind synchronous solutions.
- There will always be examples where GALS performs particularly well over a pure synchronous solution (and vice versa).
- GAL circuits are not generally smaller, faster or consume less power.
Advantages of GALS

- Facilitates synchronous design
- Limits the complexity of synchronous designs.
- Back-end design becomes more manageable.

Page 11
Advantages of CALS

- Facilitates synchronous design
- Limits the complexity of synchronous designs. Back-end design
- Regulates data transfers
- For the system becomes more manageable
- Back-end design interfaces.

CALS forces the designer to use proper handshaking at all interfaces.
Advantages of GALs

- Facilitates synchronous design
  - Limits the complexity of synchronous designs. Back-end designs
- Regulates data transfers
  - For the system becomes more manageable
- GALS modules are (or at least should be) re-usable
  - Interfaces
  - GALS forces the designer to use proper handshaking at all interfaces.
- GALS modules can be added to a system regardless of the local constraints.
Advantages of GALS

- Facilitates synchronous design
  - Limits the complexity of synchronous designs. Back-end designs become more manageable.
- Regulates data transfers
  - For the system becomes more manageable.
- Separates functionality from communication
  - Globally synchronous interfaces perform the functionality, globally.
  - Locally synchronous islands perform the communication.
- Interfaces are re-usable
  - GALS modules can be added to a system regardless of the local constraints.
- Proper handshaking at all interfaces
  - GALS forces the designer to use proper handshaking at all interfaces.
- Provides a good platform for Network-on-Chip solutions
  - Asynchronous part provides the communication.
- GALS modules are re-usable
  - GALS modules are (or at least should be) re-usable.

Integrated Systems Laboratory
Synchronous design is constrained by the area that a clock signal can propagate within a clock period.

Svennson predicts a 10 GHz clock can be used in a fully synchronous block for about 1 mm diameter.


Regionally Synchronous

Exact numbers are debatable, but classic synchronous design will have its limits. Solution: Use a regionally synchronous approach.

Divide the design into regions that can be designed using synchronous design methodologies. Then provide a method for interconnecting these regions.
Regionally Synchronous

Exact numbers are debatable, but classic synchronous design will have its limits. Solution: Use a regionally synchronous approach.

GALS is by far the most researched / developed / structured methodology for a regionally synchronous system. Divide the design into ‘regions’ that can be designed using synchronous design methodologies. Then provide a method for interconnecting these regions.

Regionally Synchronous
but global communication does not have to be asynchronous!

Regionally synchronous for a regionally synchronous system,

GALS is by far the most researched / developed / structured method for interconnected these regions.

Use a regionally synchronous approach

have its limits. Solution: Exact numbers are debatable, but classic synchronous design will...
Conclusions

- GALS does not offer significant advantages (nor penalties) in classical design parameters like area, speed and even power!
- Given the trend in manufacturing technology decreasing feature sizes, increasing clock frequencies and (near) constant area, classical synchronous design will reach a limit.
- GALS does not offer significant advantages (nor penalties) in classical design parameters like area, speed and even power!
- Using a regionally synchronous method such as GALS will be a (the only) solution to this problem.
- And yes, there is hope for GALS in the future :)