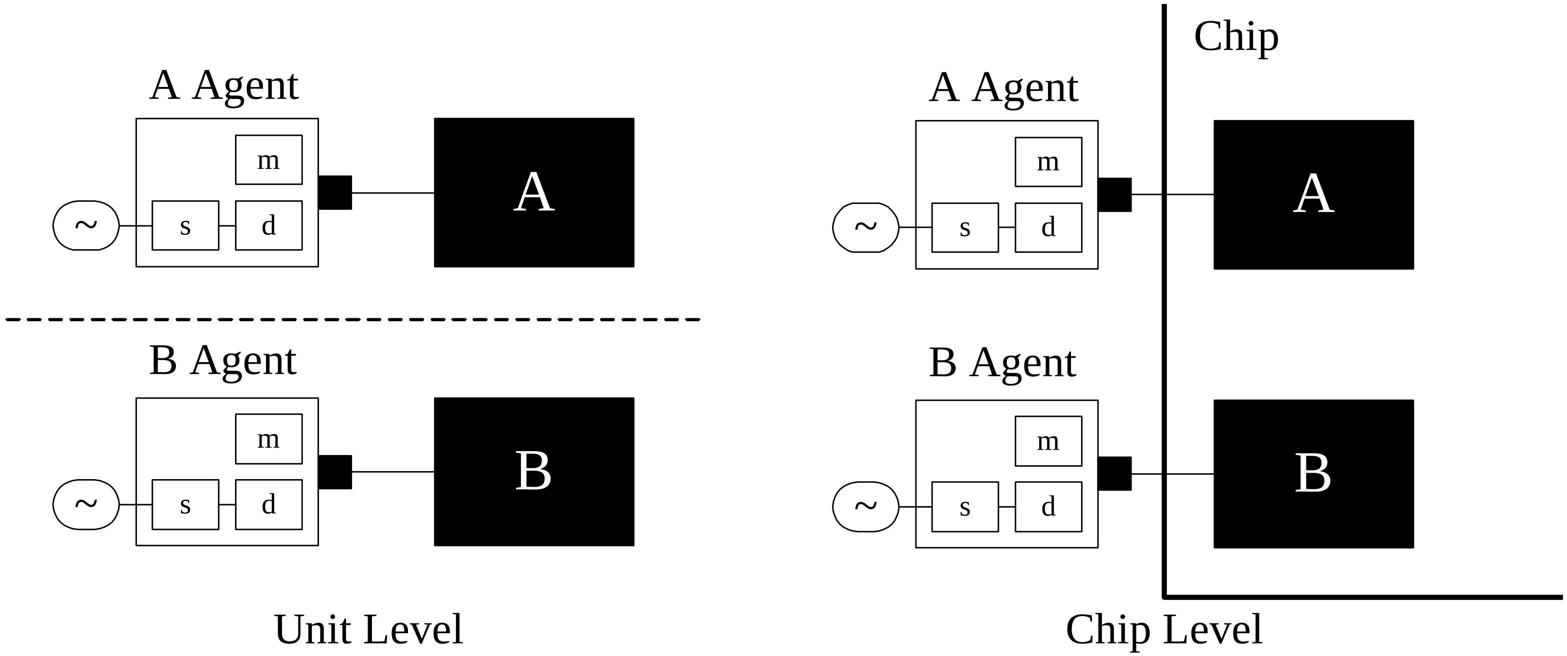
The Universal Translator

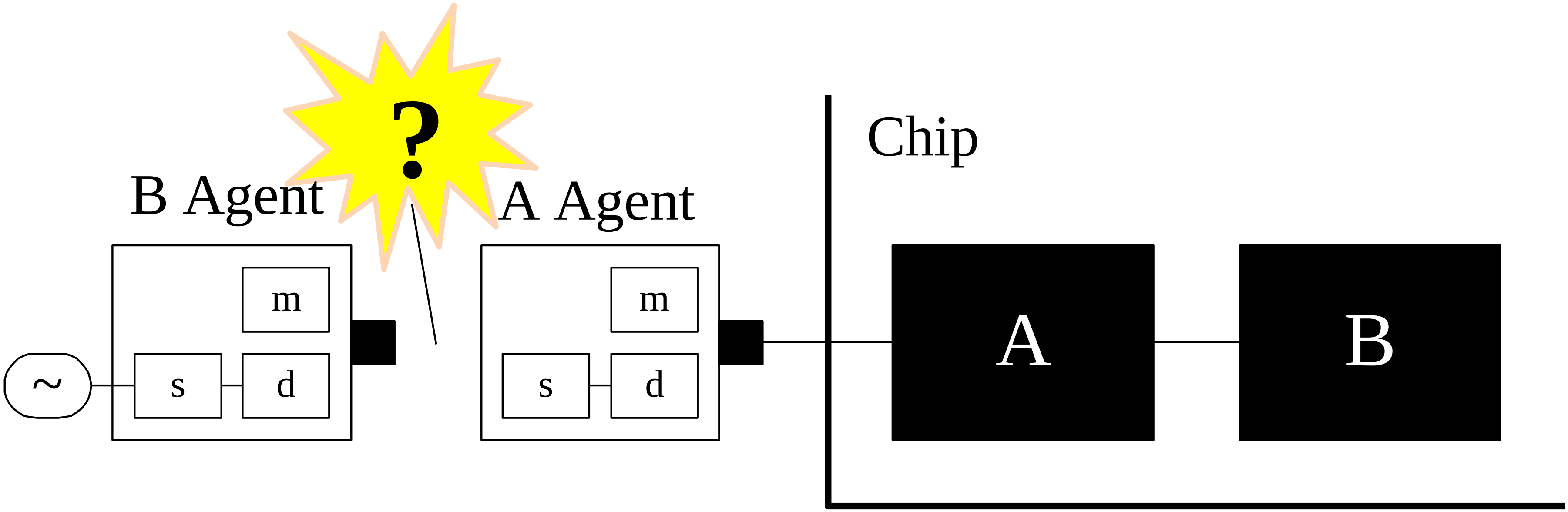
David Cornfield
dcornfield@apm.com

Traditional Agents



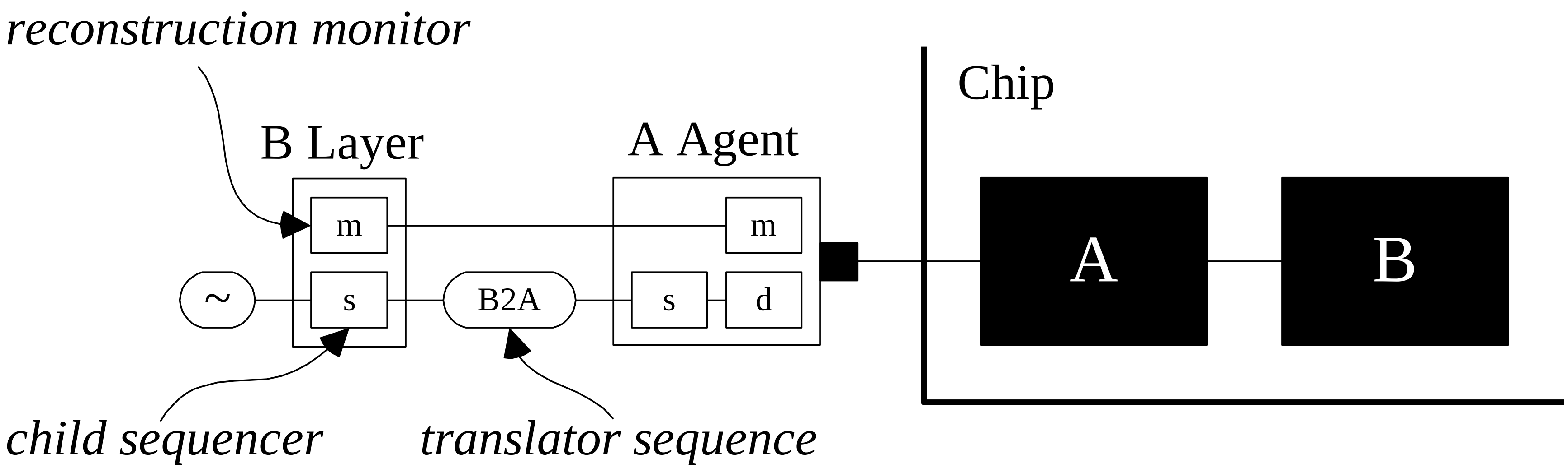
- Unit I/O exposed in both scopes
- Agent shared across both scopes

Cascaded Usage



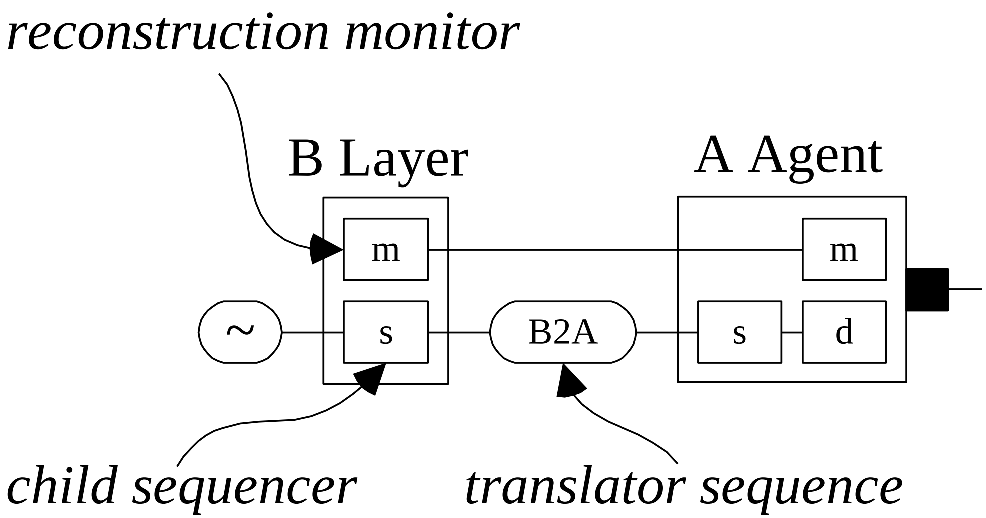
- Unit I/O not exposed in both scopes
- Can't connect virtual interface to a port

Sequence Layering



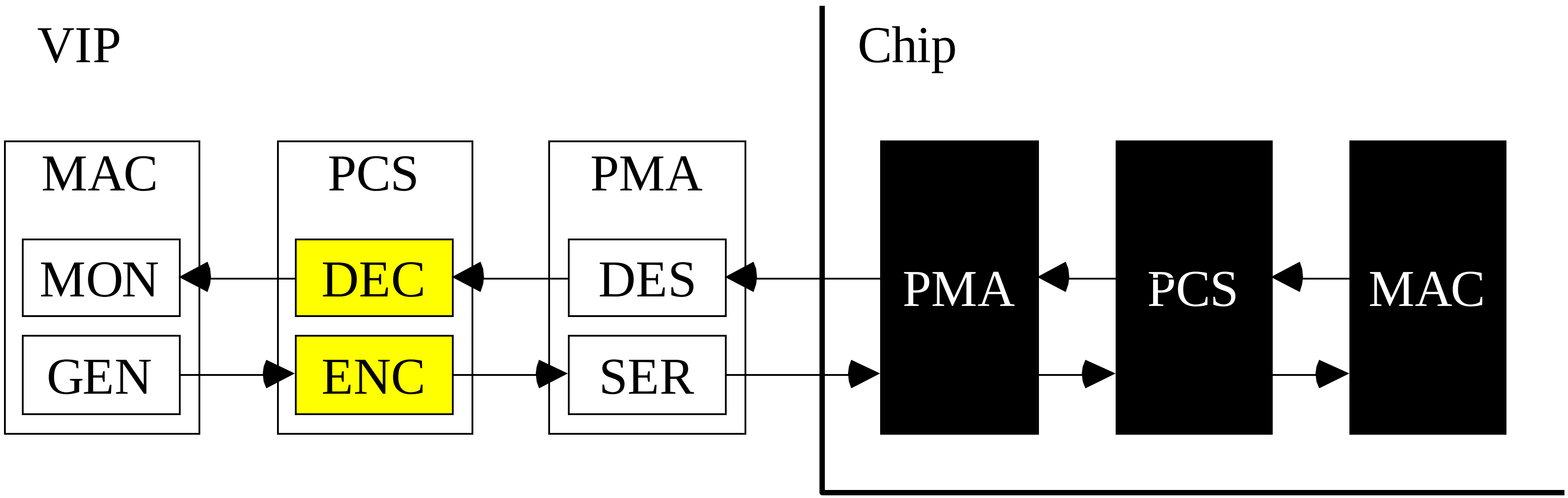
- Advanced by Tom Fitzpatrick of Mentor

Sequence Layering



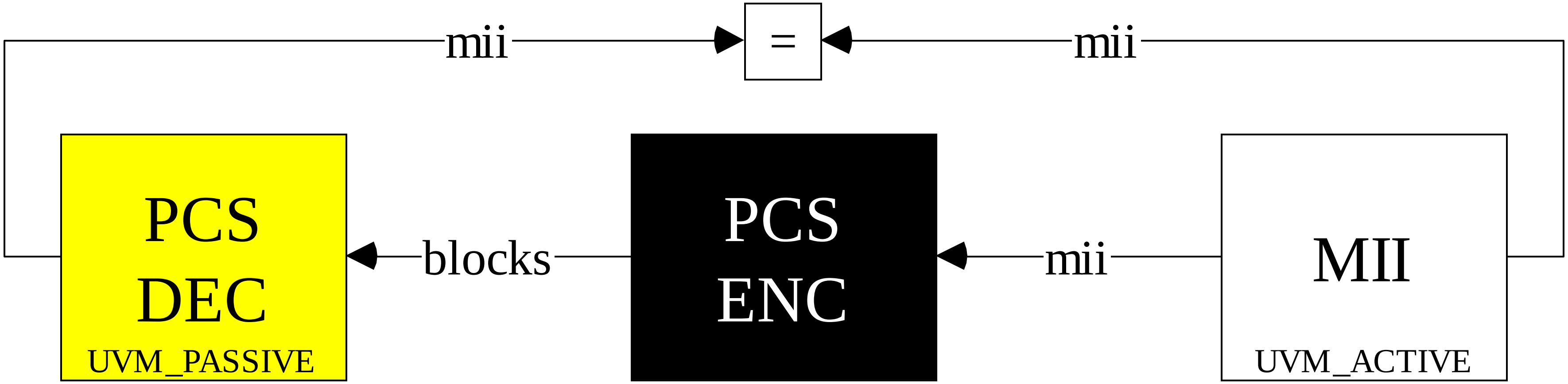
- Asymmetry
- Peripheral Clutter
- Packaging Ambiguity
- Semantic Dependency

Semantics – Top Level



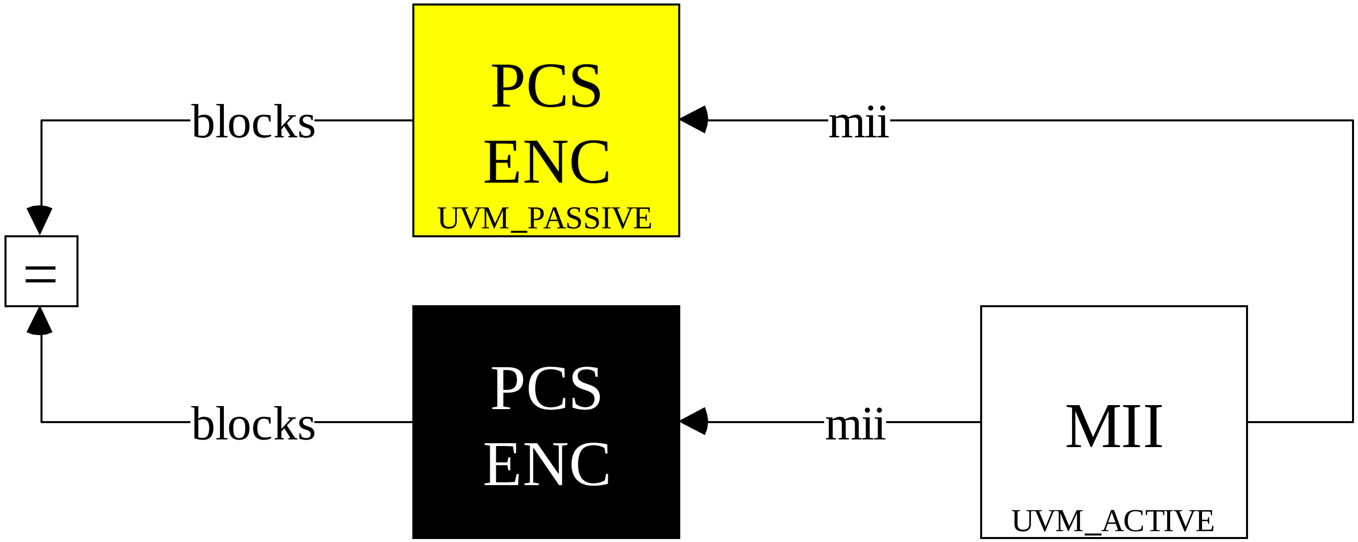
- PCS ENC VIP has **PULL** Semantic at Top Level
- PCS DEC VIP has **PUSH** Semantic at Top Level

Semantics – Unit Level



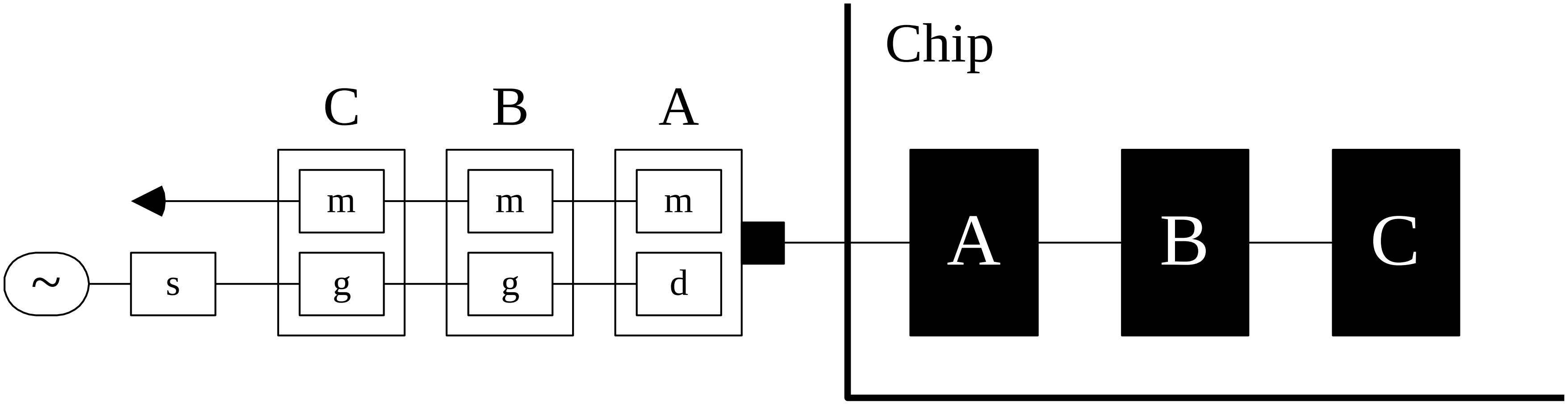
- Encoder DUT *reversed by* Decoder VIP
- Decoder VIP has **PUSH** Semantic
  - Same Semantic as Top Level Context
- **WRONG** – The DUT is a one-way function!

Semantics – Unit Level – Correct



- Encoder DUT *compared against* Encoder VIP
- Encoder VIP has **PUSH** Semantic
  - Opposite Semantic as Top Level Context
- **One function, two semantic contexts!!**

If Only …



- Component based Architecture
- Connected with Ports
- Semantic Independence

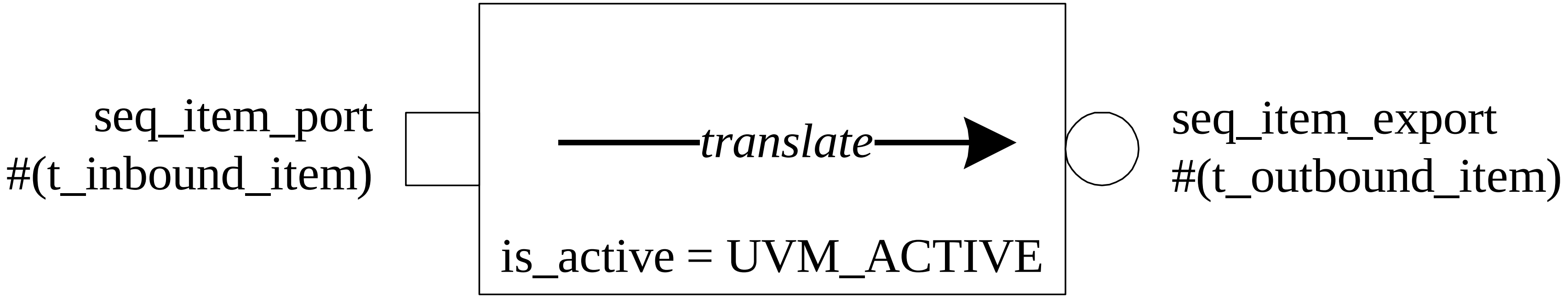
The Translator Class

The Translator Class

- A ***Translator*** is a `uvm_component` that translates a stream of *inbound items* into a stream of *outbound items*.

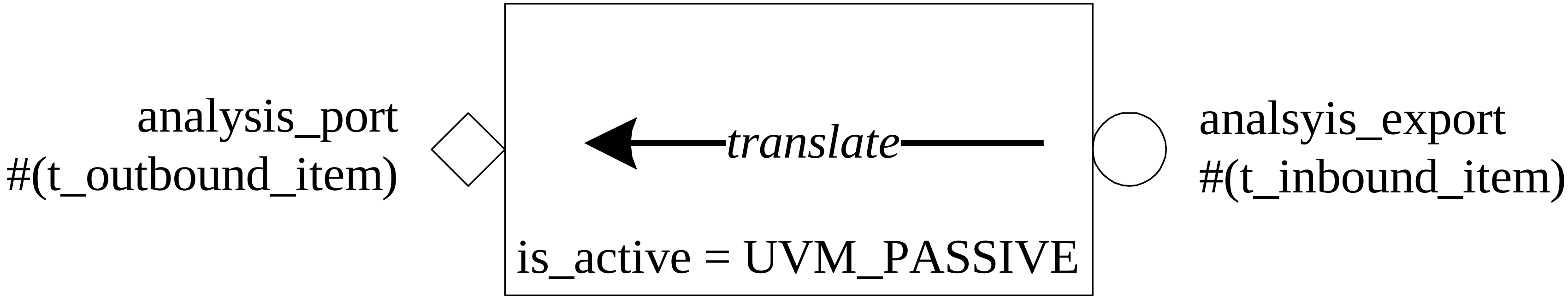
```
virtual class translator #(
  type t_inbound_item  = uvm_sequence_item,
  type t_outbound_item = uvm_sequence_item
  ) extends uvm_component;

  pure virtual task translate();

endclass
```

`UVM_ACTIVE` Translation



- Outbound items are **PULLED** out the `seq_item_export`
- Inbound items are **PULLED** in the `seq_item_port`
- Translate from inbound to outbound

`UVM_PASSIVE` Translation



- Inbound items are **PUSHED** in the `analysis_export`
- Outbound items are **PUSHED** out the `analysis_port`
- Translate from inbound to outbound

The Translation API

- Derivatives implement the `translate` task calling:

```
get_inbound_item  ( output t_inbound_item item );
try_inbound_item  ( output t_inbound_item item );
put_outbound_item ( input t_outbound_item item );
put_uncloned_outbound_item (
                   input t_outbound_item item );
```

- Always follow a *get-transform-put* pattern
- Can be periodic 1:1, 1:M, M:1, M:N *or* aperiodic
- Same task called in *both* semantic contexts

```
class pcs_encoder extends
  translator #(t_mii_transfer, t_block);
```

From t_mii_transfers **To** t_blocks

```
  task translate();
    t_mii_transfer t1,t2;
    t_block        block;

    get_inbound_item(t1);
    get_inbound_item(t2);

    block = encode(t1,t2);

    put_outbound_item(block);
  endtask
endclass
```

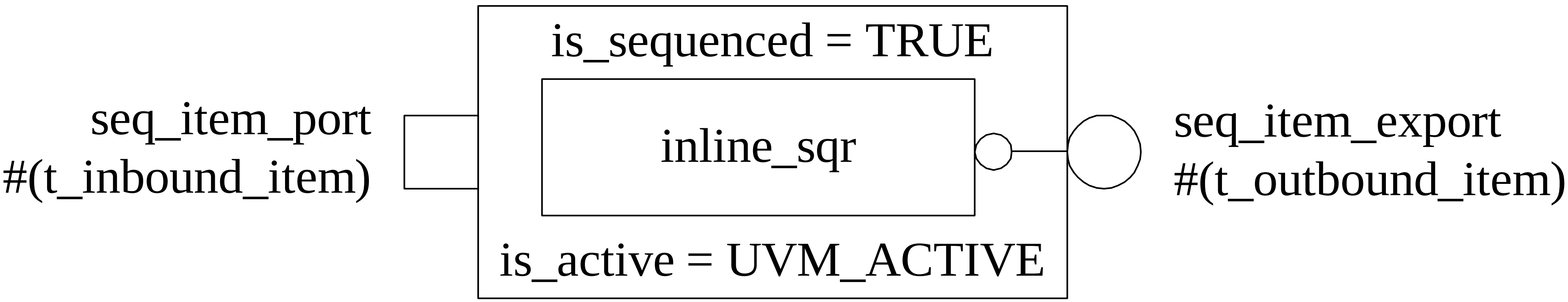
Get

Transform

Put

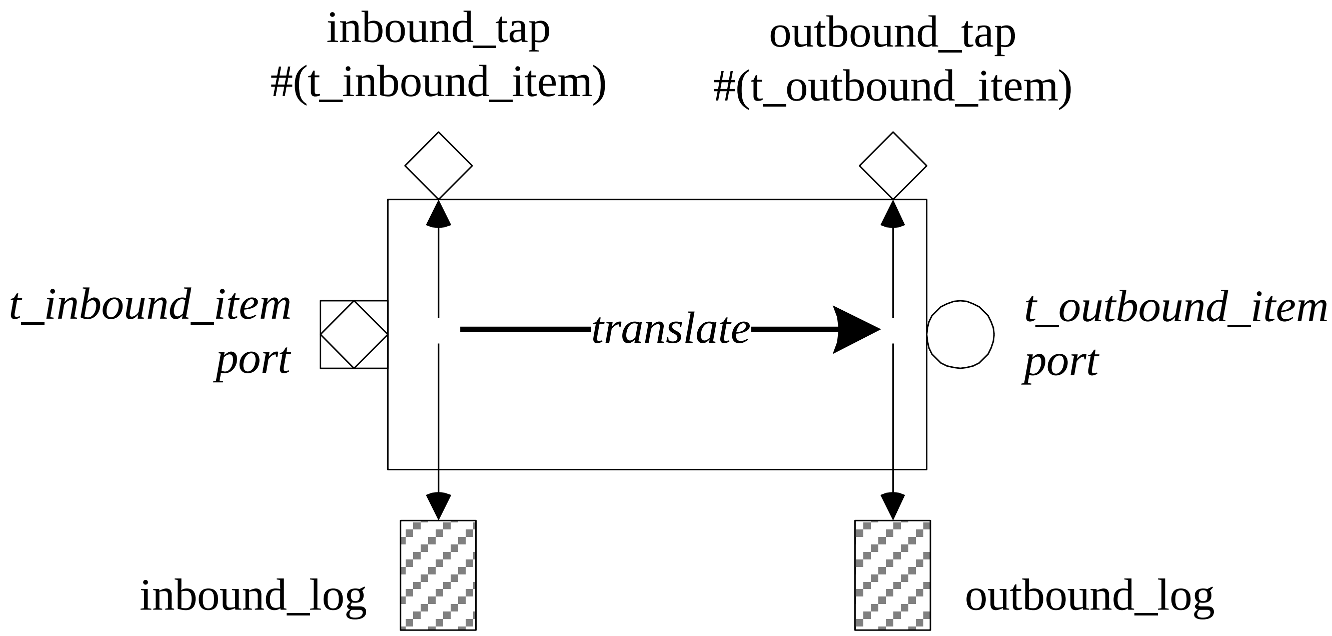
2 :1 Periodicity

Inline Sequencing



- Outbound items no longer directly controllable
- No possible input sequence to result in the desired output sequence
- Generally only an issue for stimulus generation

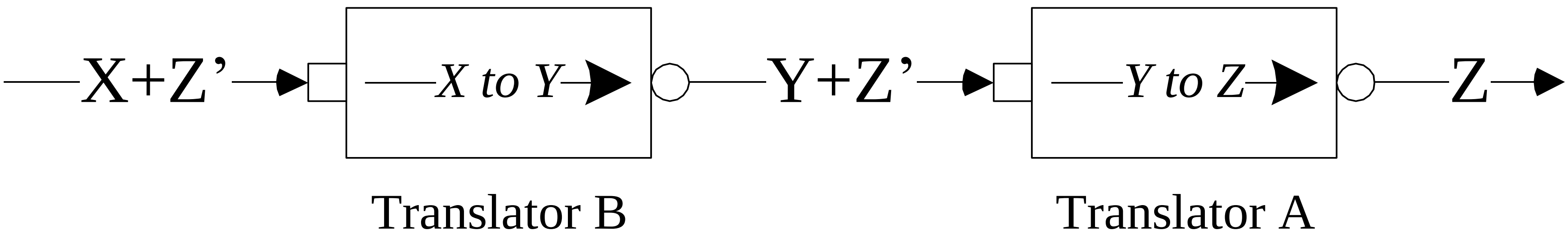
Debug Hooks



- Optional Inbound/Outbound item analysis taps
- Optional Inbound/Outbound item logging

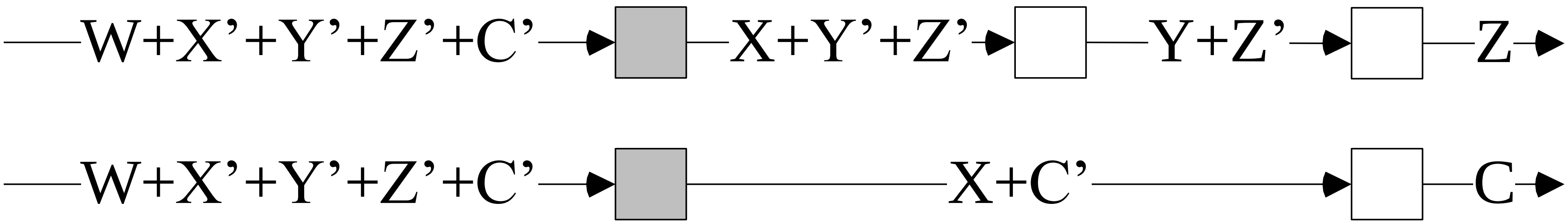
Orthogonal Sequencing

Control Knob Pollution



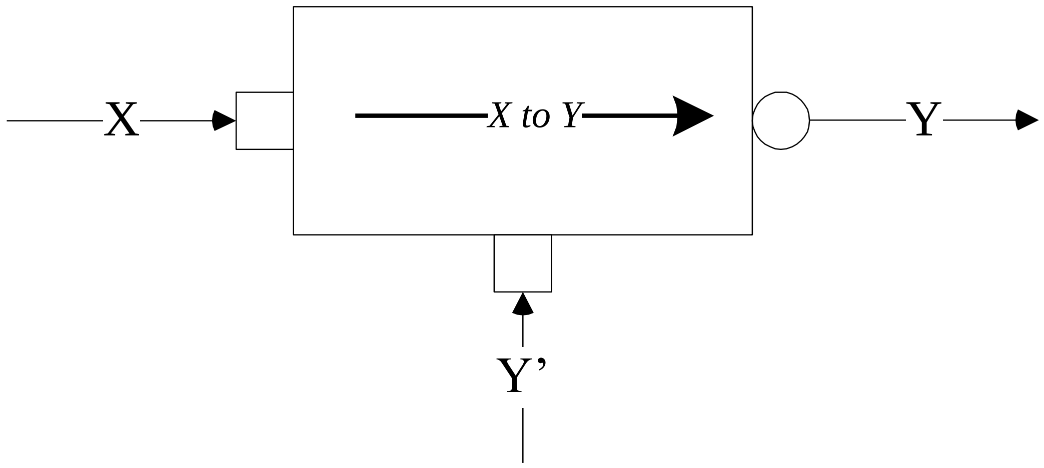
- Control knobs, Z', for Z items show up in X items
- A Z' has nothing to do with an X item
- Translator B must be Z' aware to pass them through

Control Knob Explosion



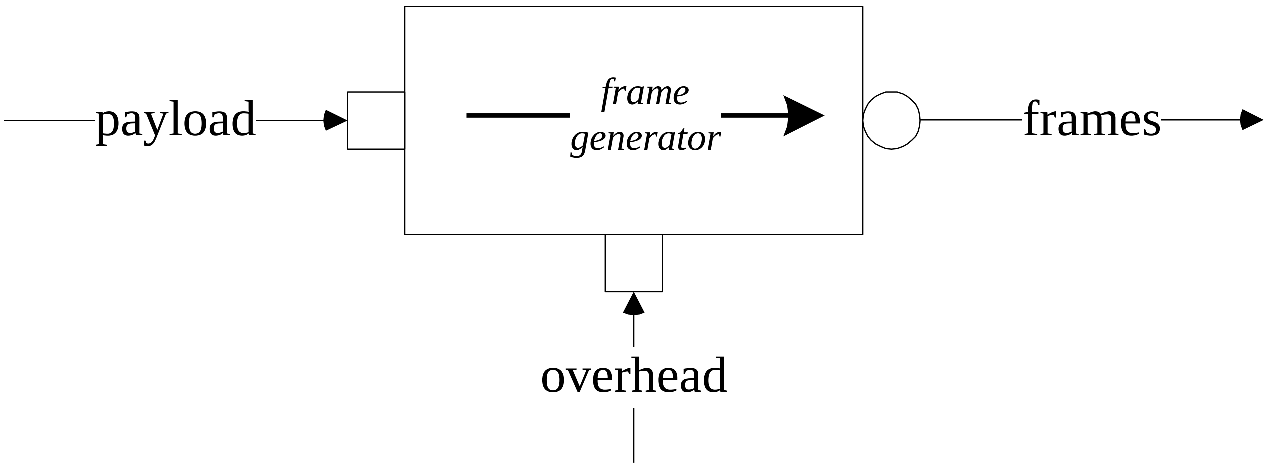
- Control Knobs accumulate with each link and with each usage context

Orthogonal Sequencing



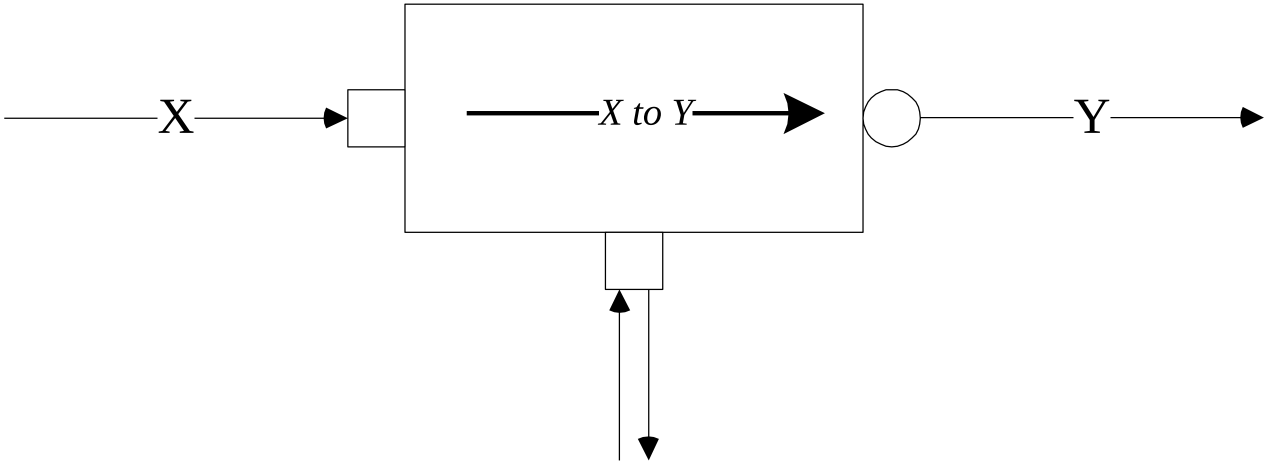
- Control sequenced separately from Data
- X timed, Y timed or independent

Dynamic Translation



- Why be limited to Control Knobs for Error Insertion?
- Example: Encapsulation

Adaptive Translation



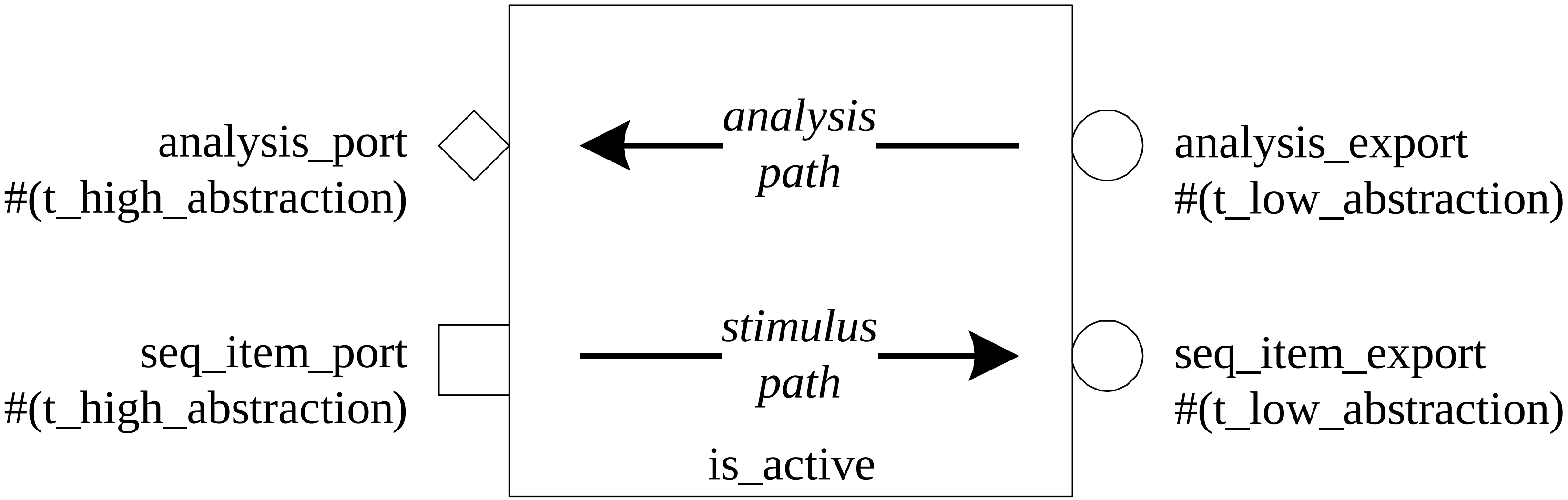
- Response Channel used to tune the Dynamic translation.
- Example: IPG requested vs IPG actual

Package Isolation

- Helps resolve package dependency
- Package boundaries have are one of four data types:
  - A *packet* `bit [7:0] data[];`
  - A *frame* `bit [0:FL-1][7:0] data;`
  - A *bitstream* `bit [BW-1:0] data;`
  - A *bundle* `bit [0:LC-1][BW-1:0] data;`

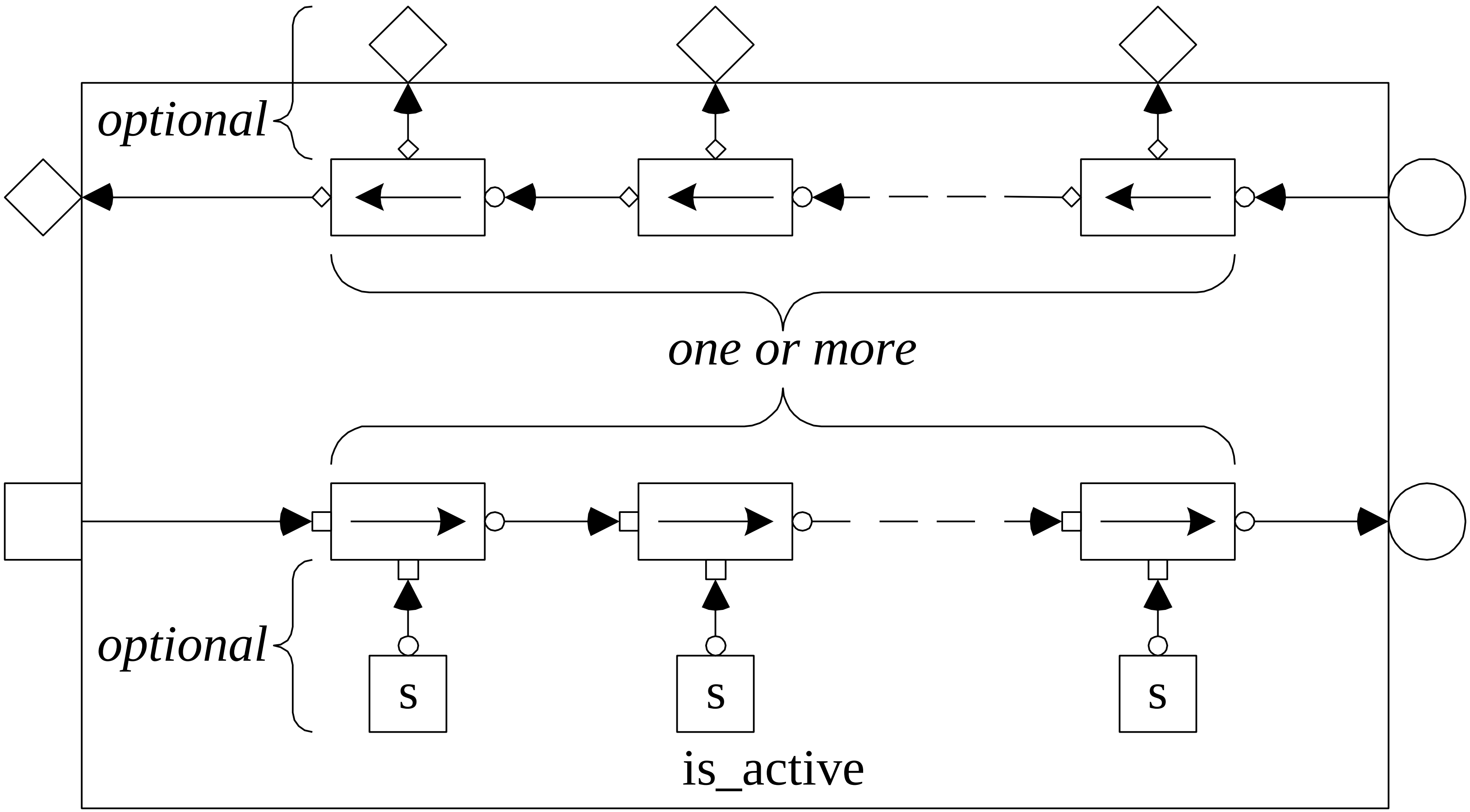
The Layered Architecture

Layers

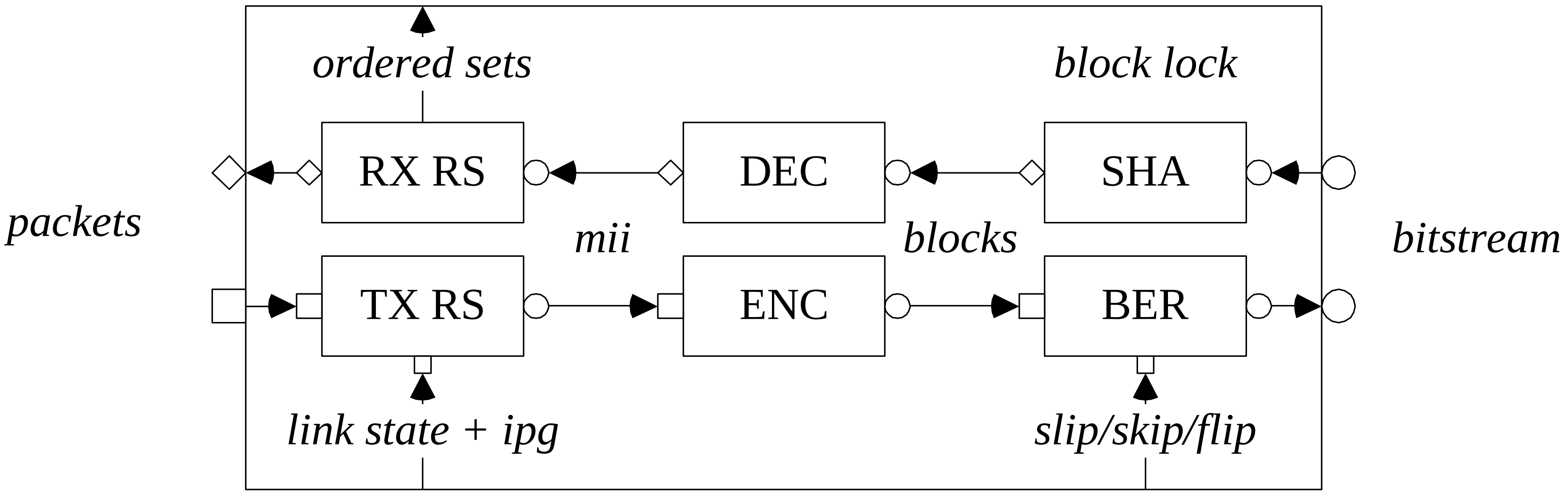


- A ***Layer*** translates from *low abstraction* to *high abstraction* in the *analysis path*, AND from *high abstraction* to *low abstraction* in the stimulus path

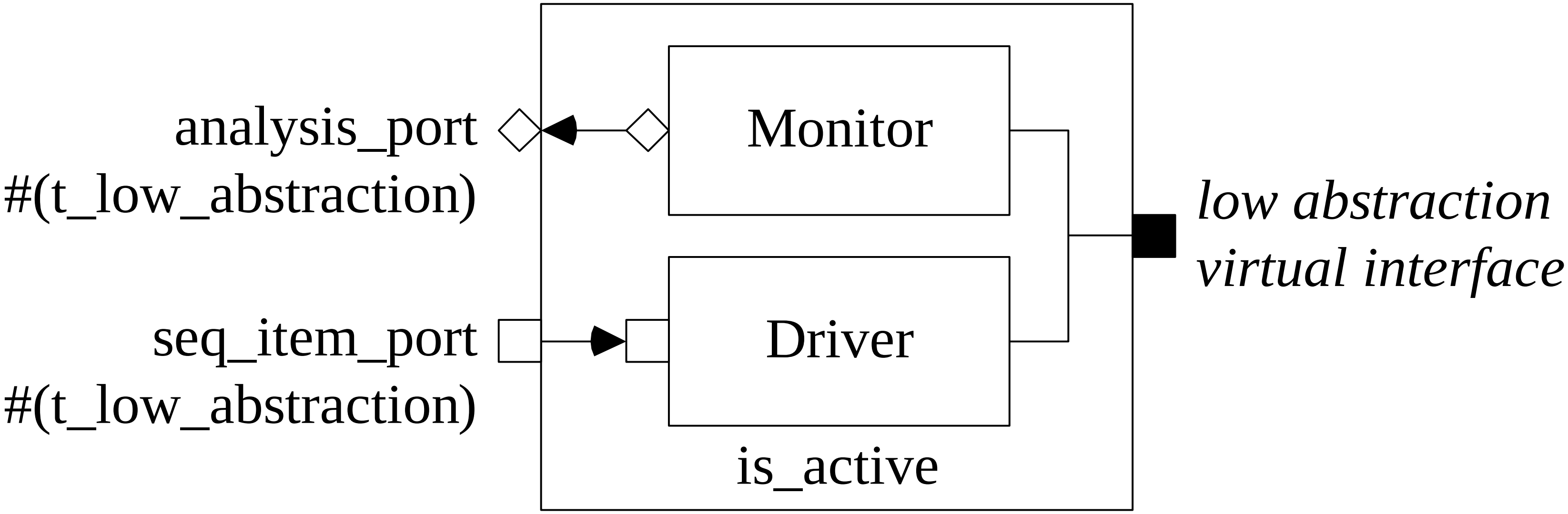
Layer Implementation



Layer Example – Ethernet PCS

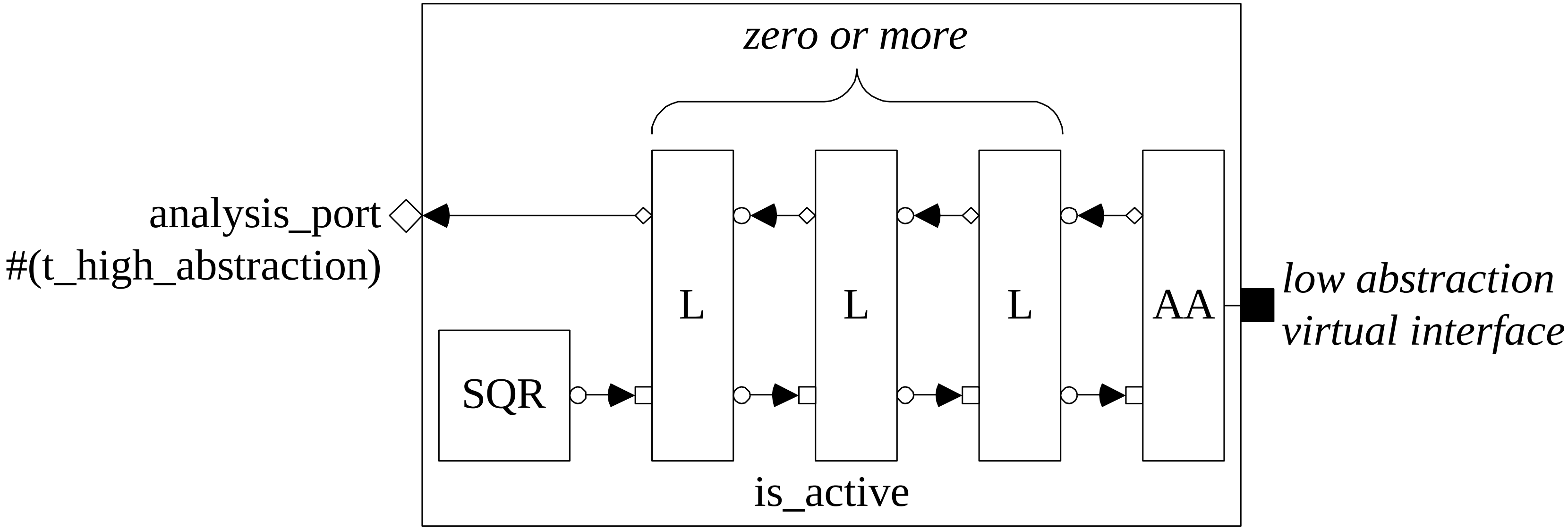


Attachment Agents



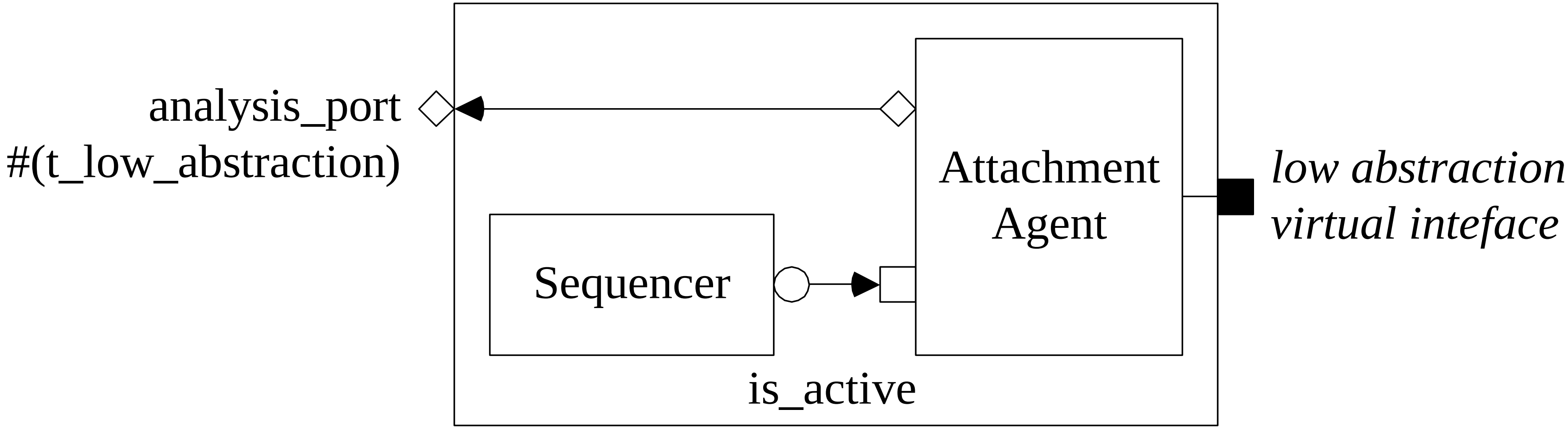
- An ***Attachment Agent*** is a Traditional Agent without a sequencer

Chains



- A ***Chain*** connects a sequencer to an Attachment Agent and has zero or more intervening Layers.
- A Chain is *simple* if it has only one layer.

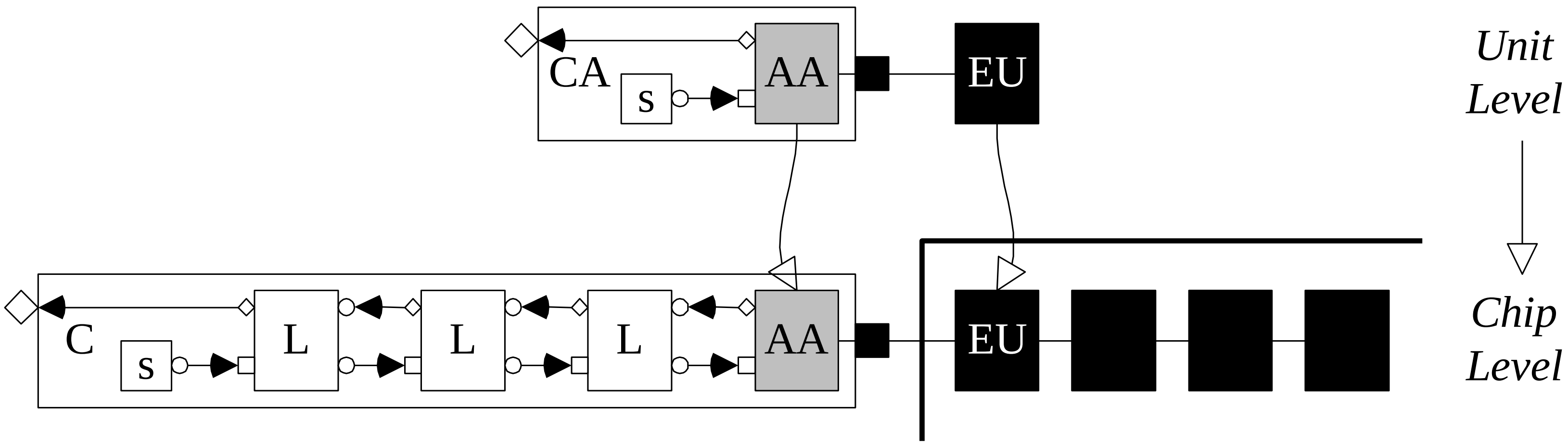
Chainable Agents



- A ***Chainable Agent*** is a Chain with no Layers
- Degenerate case similar to a Traditional Agent

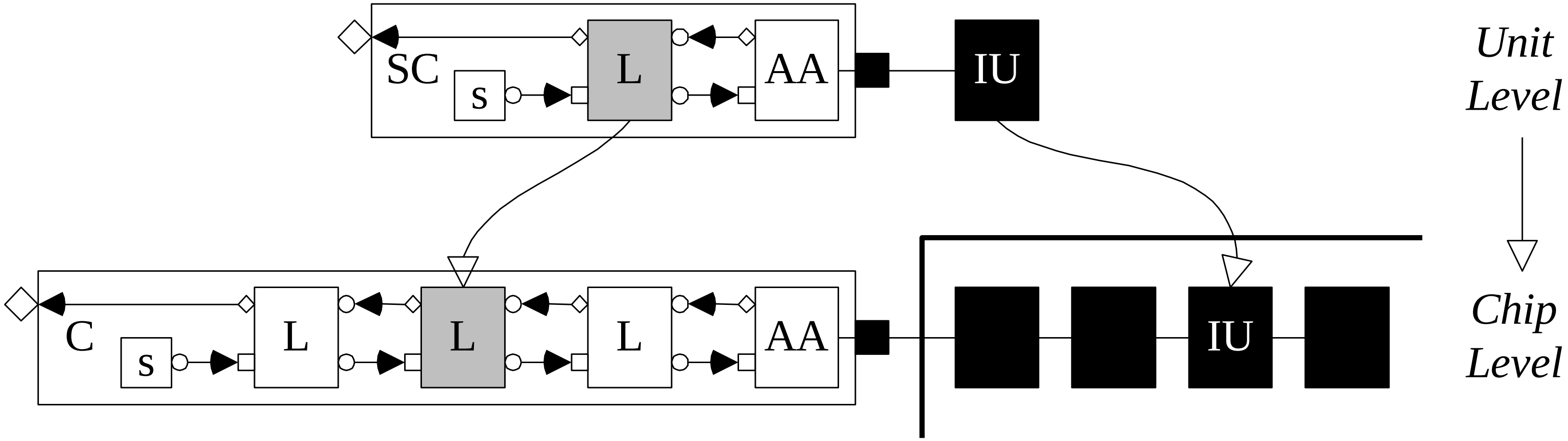
Usage Contexts

Edge Unit Context



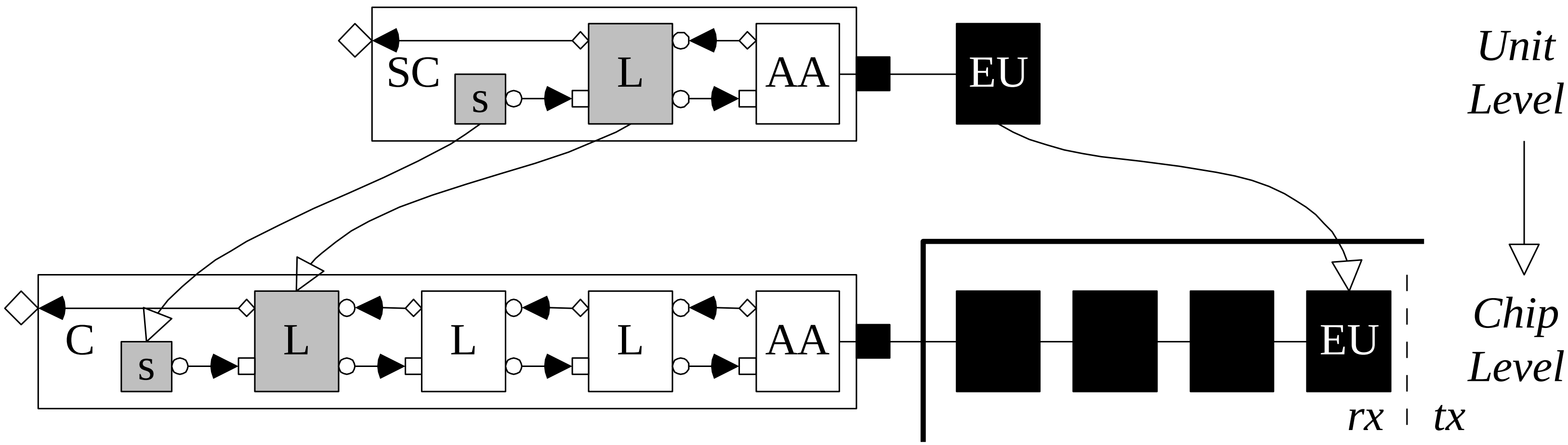
- An ***Edge Unit*** has I/O exposed in both scopes
- The Attachment Agent is ported

Internal Unit Context



- An ***Internal Unit*** has no I/O exposed at the Chip
- The Layer is ported

End Unit Context



- An ***End Unit*** is the Internal Unit adjacent to the *protocol divide*
- The Layer <u>and</u> Sequencer is ported

Conclusion

It’s in the Numbers

- 300 lines of code
- ~400 extensions
- 16 Layers, 3 Attachment Agents, 2 utility Translators
- ~240,000 simulation runs
- ~16,000 tests
- The work horse of Unit <u>and</u> Chip level tests for ~2½ years

Questions

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dcornfield@apm.com