

BUILDING AN AUTOMATED TRADING SYSTEM USING ERLANG/OPT

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Berlin Erlang Factory Light

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0 Disclaimer*



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1.1 Power quiz 1



1.2 Power quiz 2

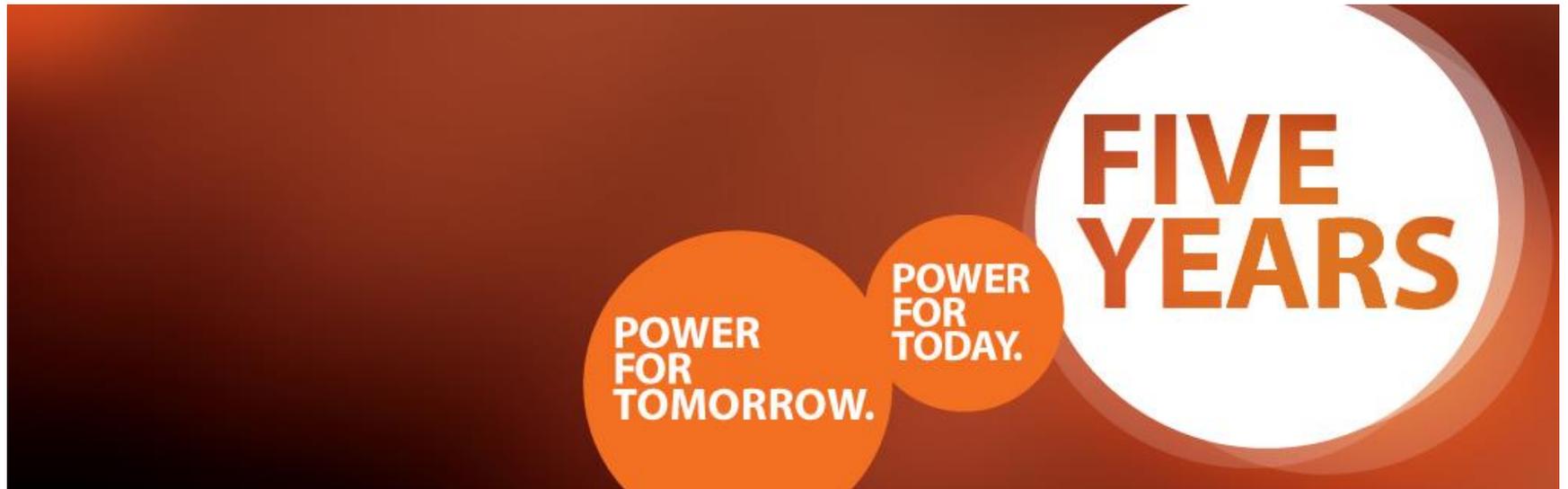


1.3 Power quiz 3



1.4 Power quiz 4

EPEXSPOT



2 Putting it all together ...

Produce

Transmit

Consume



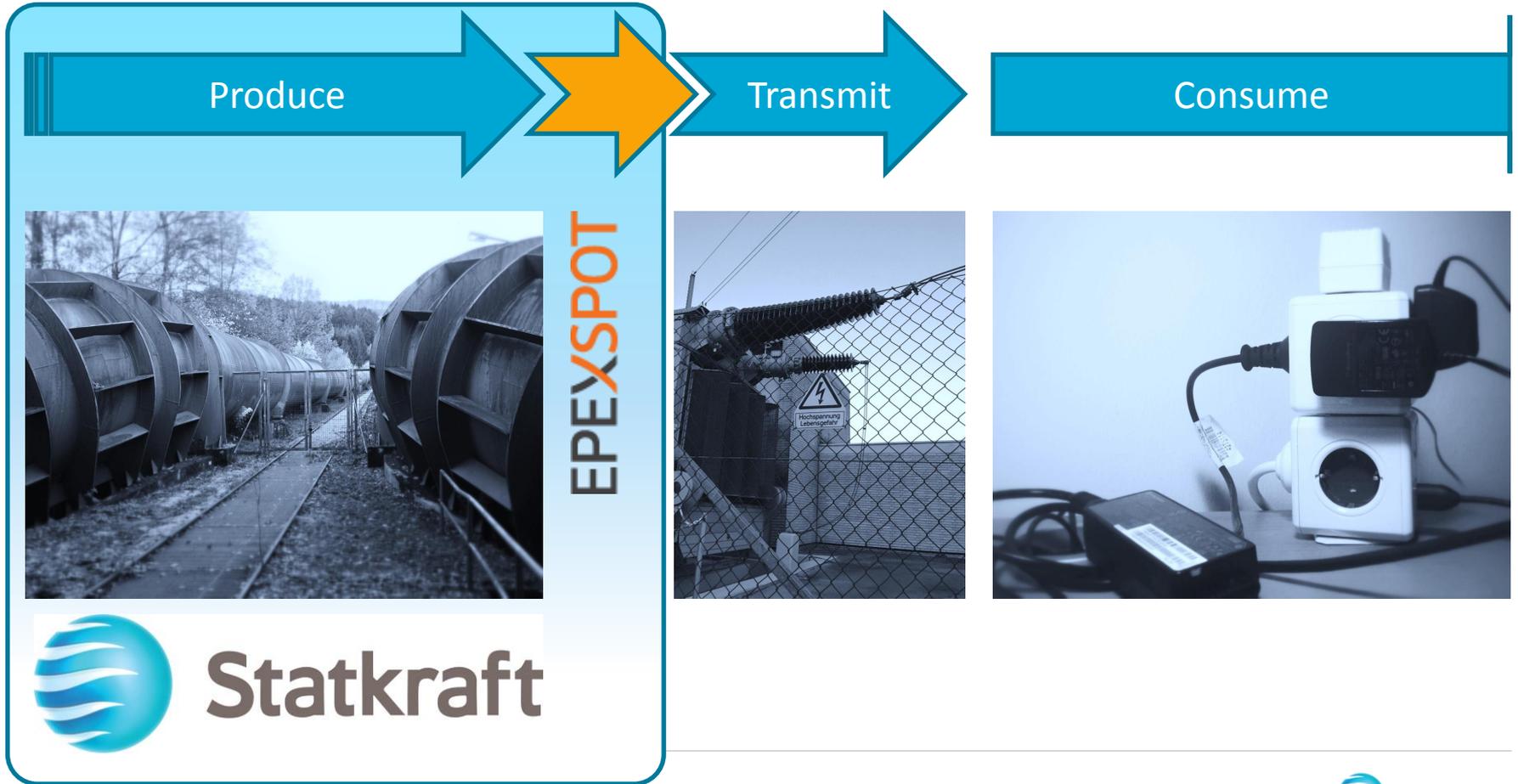
2.1 And trade...



EPEXSPOT



2.2 And where do we stand?



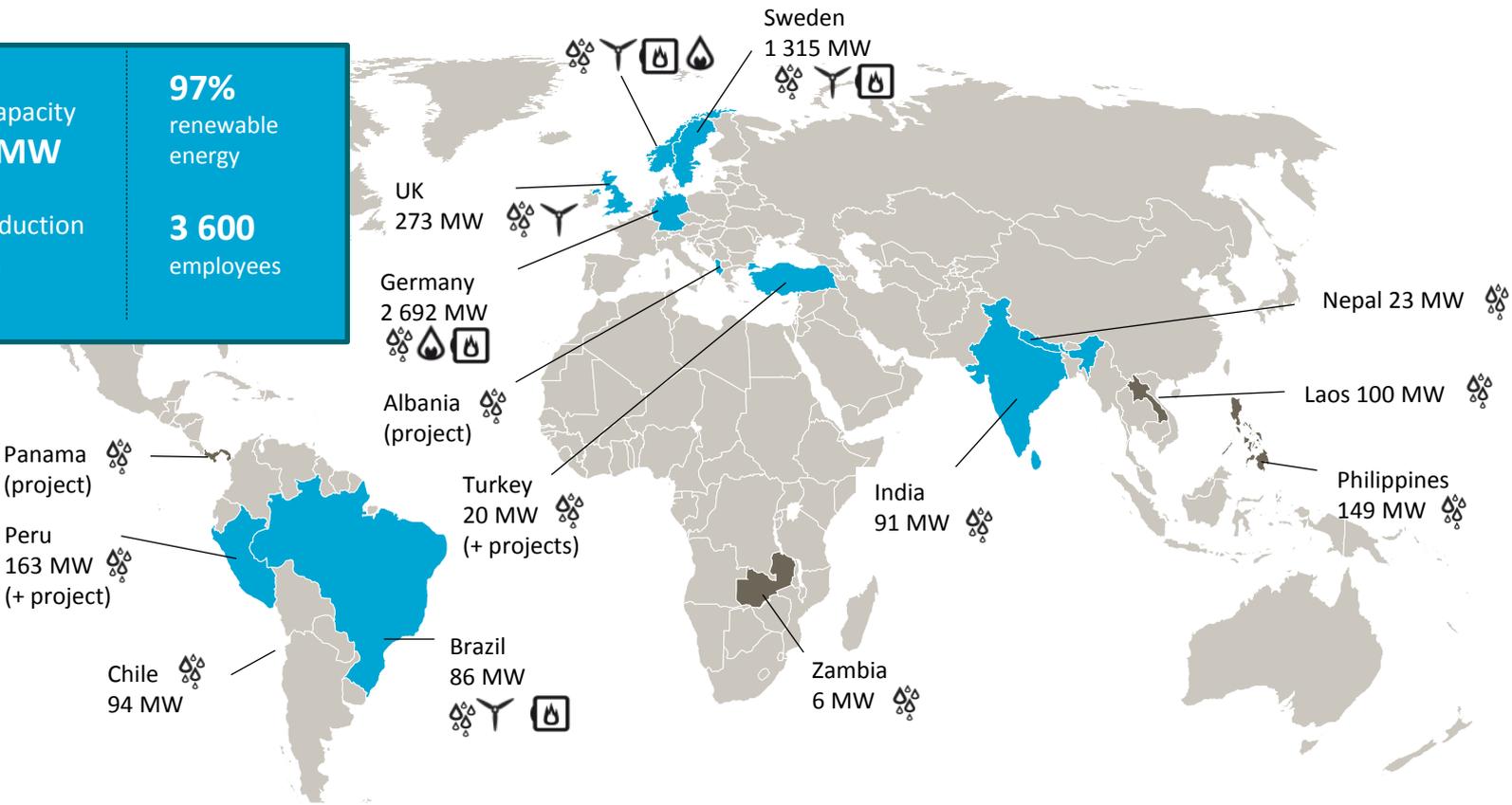
2.3 Statkraft: headquartered in Norway

Installed capacity
17 600 MW

Power production
56 TWh

97%
renewable energy

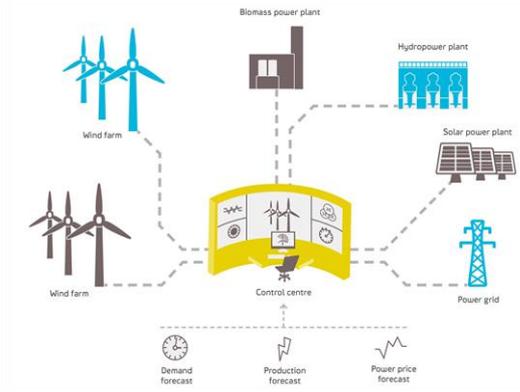
3 600
employees



2.4 Statkraft in Germany

Own generation 2 692 MW

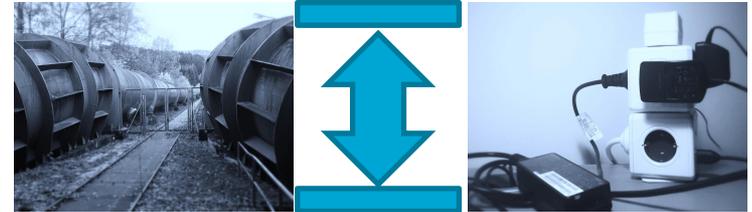
+ \approx 7 500 MW



Virtual Power Plant:
Germany's biggest asset
of remote controllable generation

3 German power market

- ▶ Physical Delivery
- ▶ Production \equiv Consumption
- ▶ EPEXSPOT - The Marketplace
 - Day Ahead Auction (12:00 D0 for D1)
 - Intraday Continuous Trading (24x7)



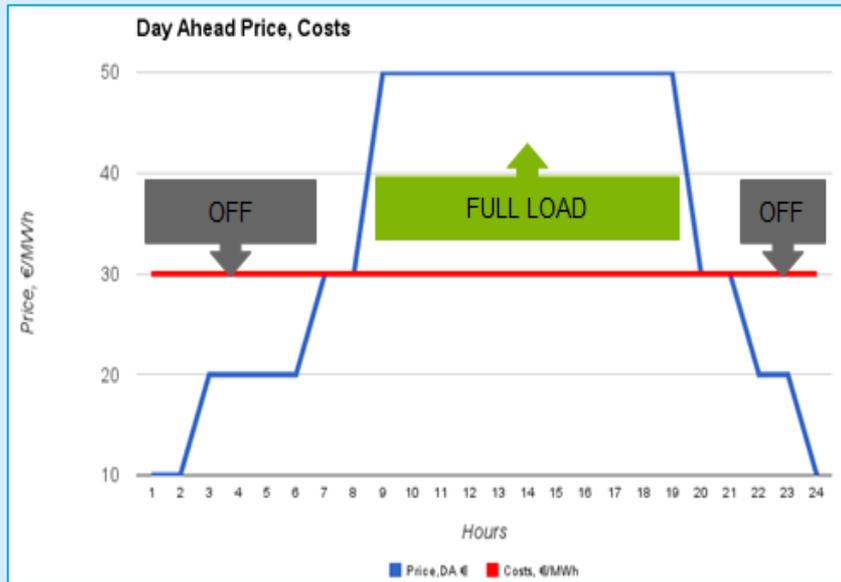
EPEXSPOT

3.1 German power market: Contracts

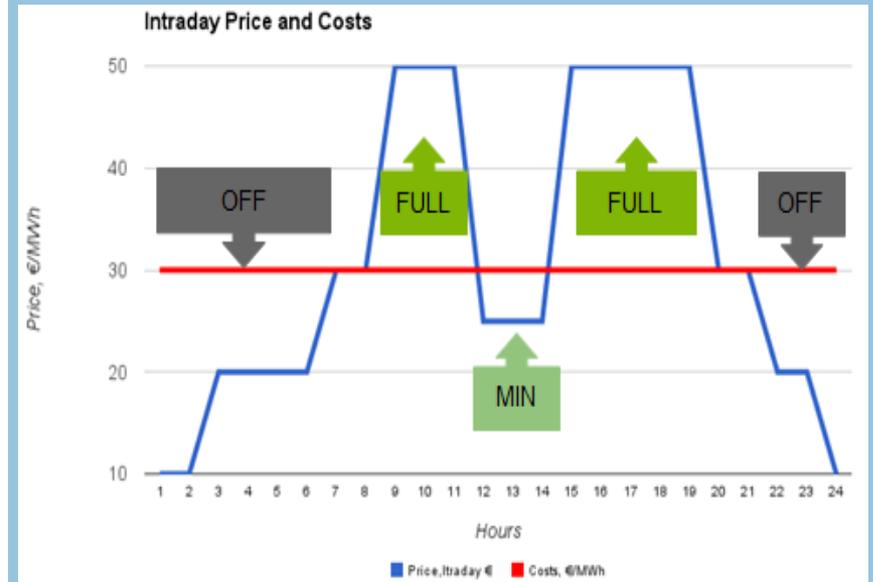
Time	07:00	07:15	07:30	07:45	08:00	08:15	08:30	08:45
Hr	H8				H9			
Qt	7Q1	7Q2	7Q3	7Q4	8Q1	8Q2	8Q3	8Q4
Block	07:00-08:00							

3.2 Intraday optimization

Day Ahead: Plan



Intraday: Optimization



4 Sharpen tools



- ▶ `amqp_client` (https://github.com/jbrisbin/amqp_client.git)
- ▶ `erlsom` (<https://github.com/willemdj/erlsom>)
- ▶ `gproc` (<https://github.com/uwiger/gproc.git>)
- ▶ `lager` (<https://github.com/basho/lager.git>)
- ▶ `rebar` (<https://github.com/basho/rebar>)
- ▶ `cowboy` (<https://github.com/extend/cowboy.git>)
- ▶ `jsx` (<https://github.com/talentdeficit/jsx>)



Jon Brisbin
jbrisbin



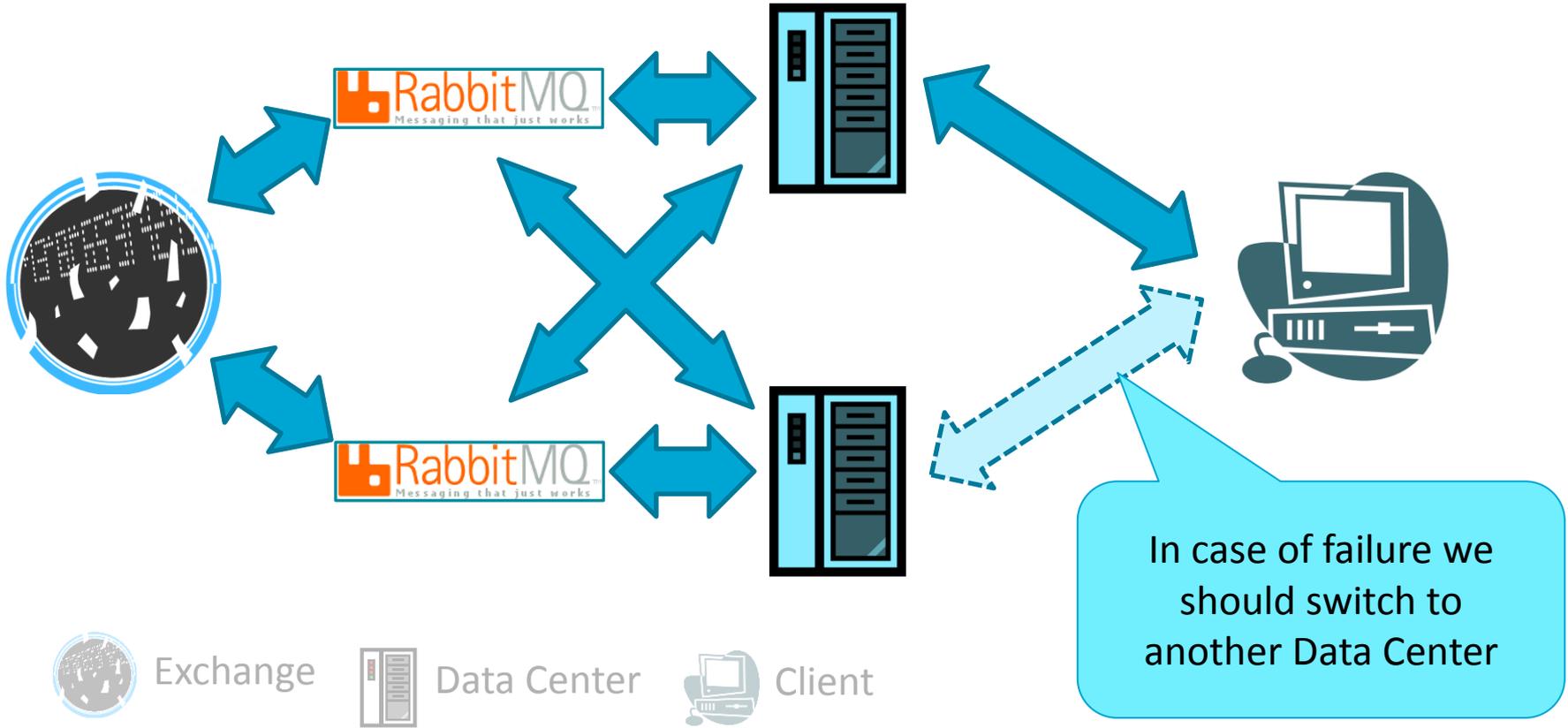
Ulf Wiger
uwiger



Alisdair Sullivan
talentdeficit



5 Infrastructure overview



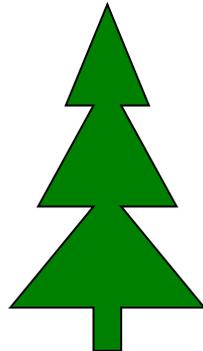
6. Do not build – Grow naturally!



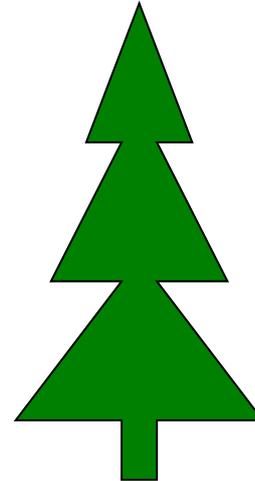
Simplest application:
Get data and show



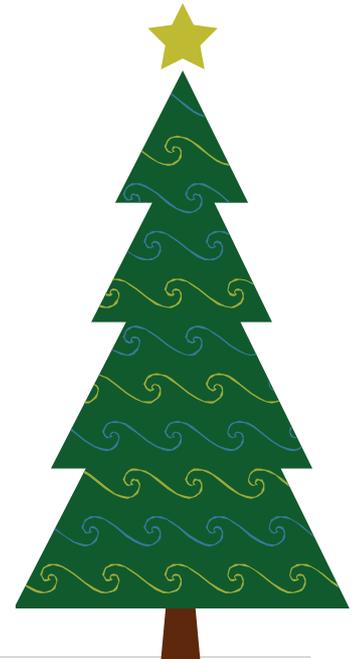
Works 24x7



Survives outages



Trim



6.1 Version 0.1. Better view on bids and offers.

► http://XXX/XXX/epex_prices.html

EVA Grid Wind Assets EPEX About Volume EPEX Messages: ON

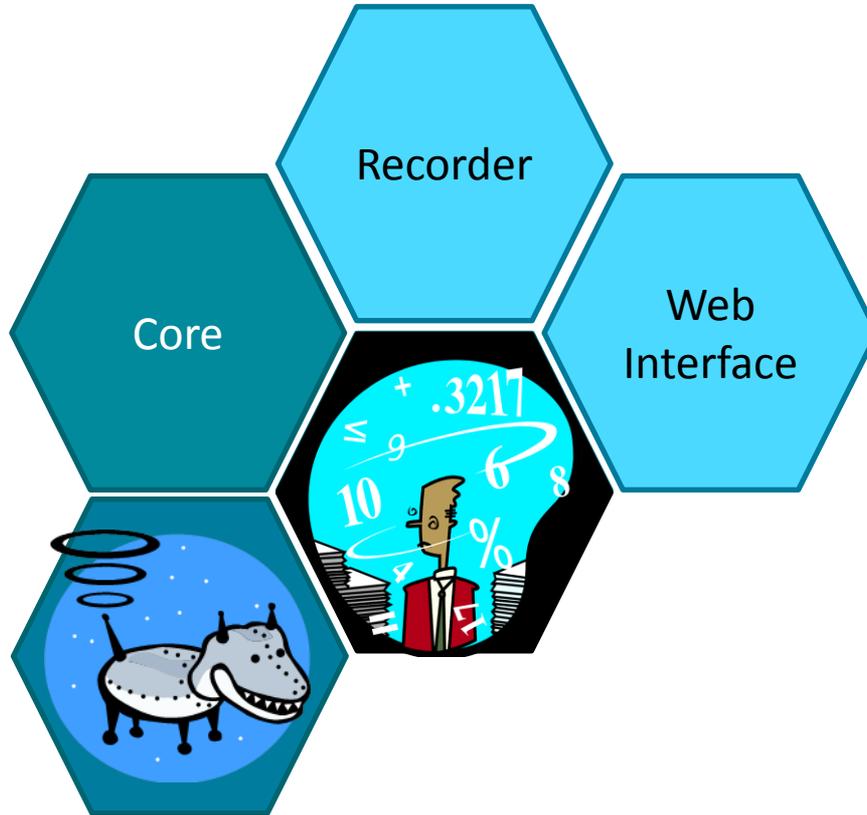
Hour	H bid	H ask	Spread	Q Avg. bid	Q Avg. ask	Spread
15-16				86.00	104.91	18.91
16-17	86.50	92.80	6.30	74.81	96.37	21.55
17-18	106.00	112.00	6.00	69.70	114.12	44.42
18-19	106.00	113.03	7.03	67.62	107.25	39.63
19-20	74.03	80.00	5.97	64.26	91.77	27.51
20-21	63.55	80.50	16.95	55.90	89.63	33.72
21-22	57.50	62.95	5.45	49.15	85.92	36.79
22-23	48.25	50.00	1.75	36.50	69.07	32.57
23-24	35.50	38.00	2.50	29.48	49.41	19.94

Weighted avg. price for the 100 MW (default)

Last messages from the Exchange

- Trade DE/DE: 16-17 - 2.0 MW for 90.80 EUR.
- Trade DE/DE: 16-17 - 4.0 MW for 90.80 EUR.
- Trade DE/DE: 16-17 - 5.0 MW for 90.80 EUR.
- Trade DE/DE: 16-17 - 1.0 MW for 90.80 EUR.
- Trade DE/DE: 16-17 - 6.0 MW for 90.80 EUR.

6.2 Trim... Version 0.2

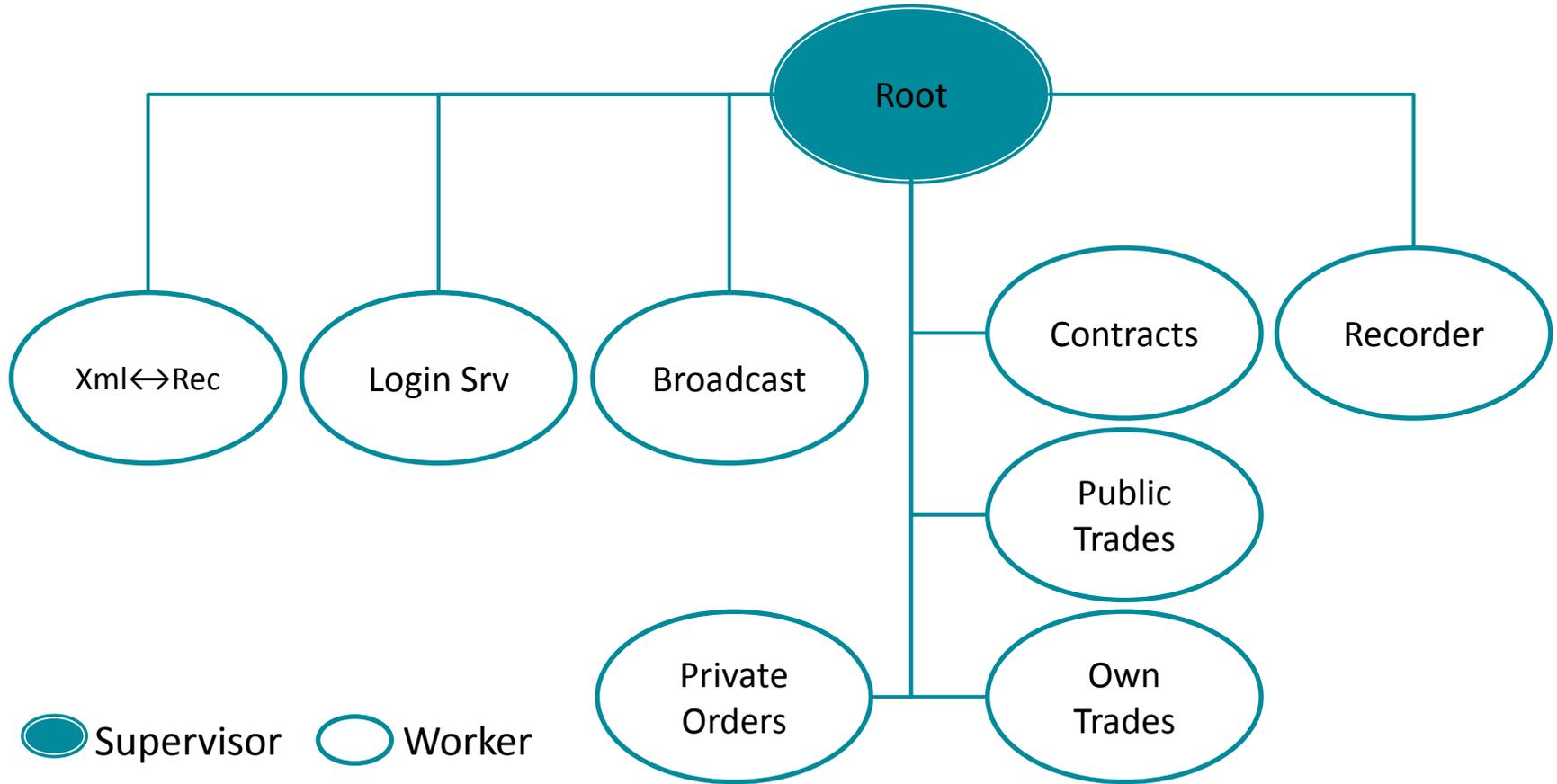


Bot

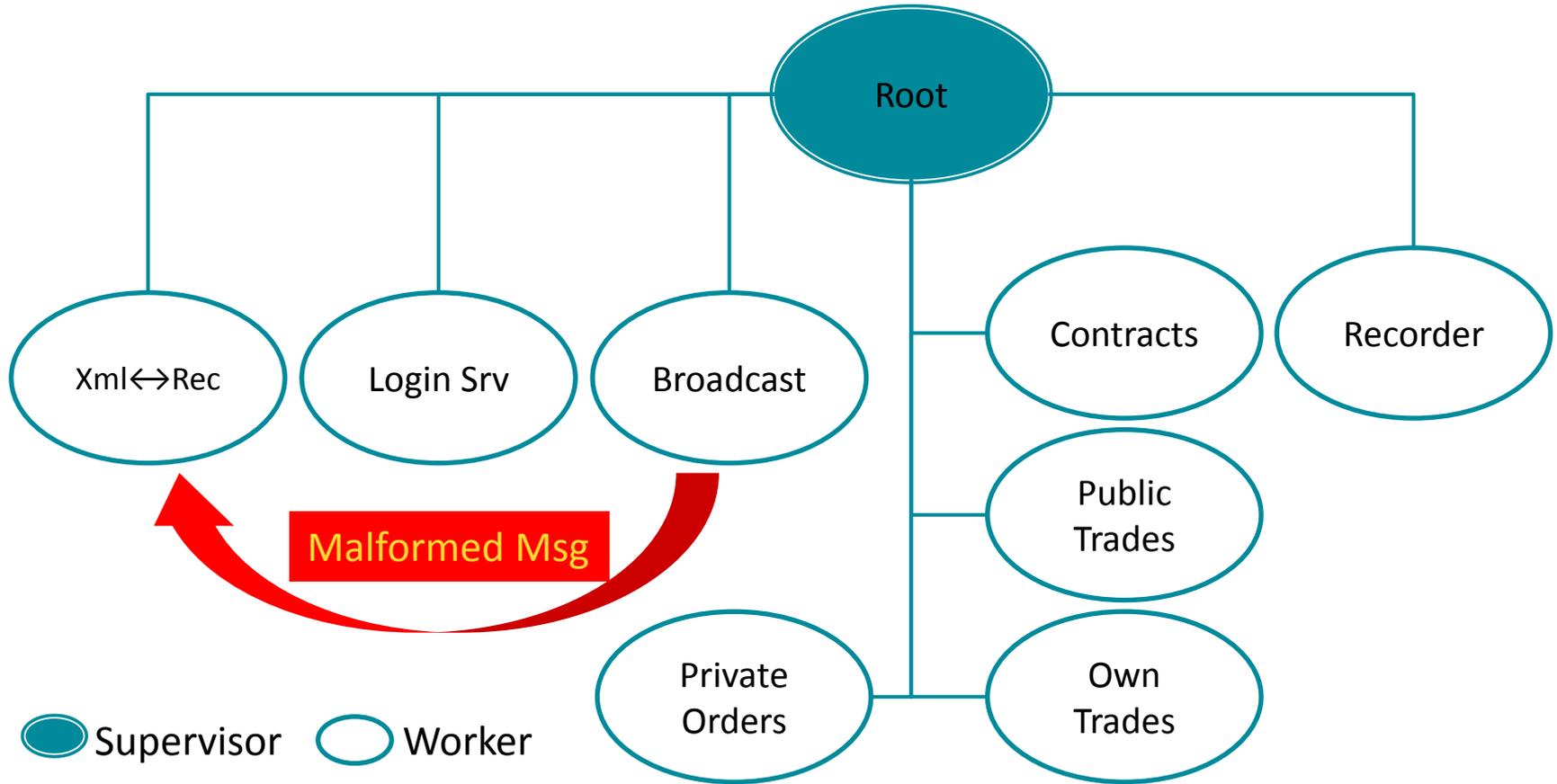


Statistics

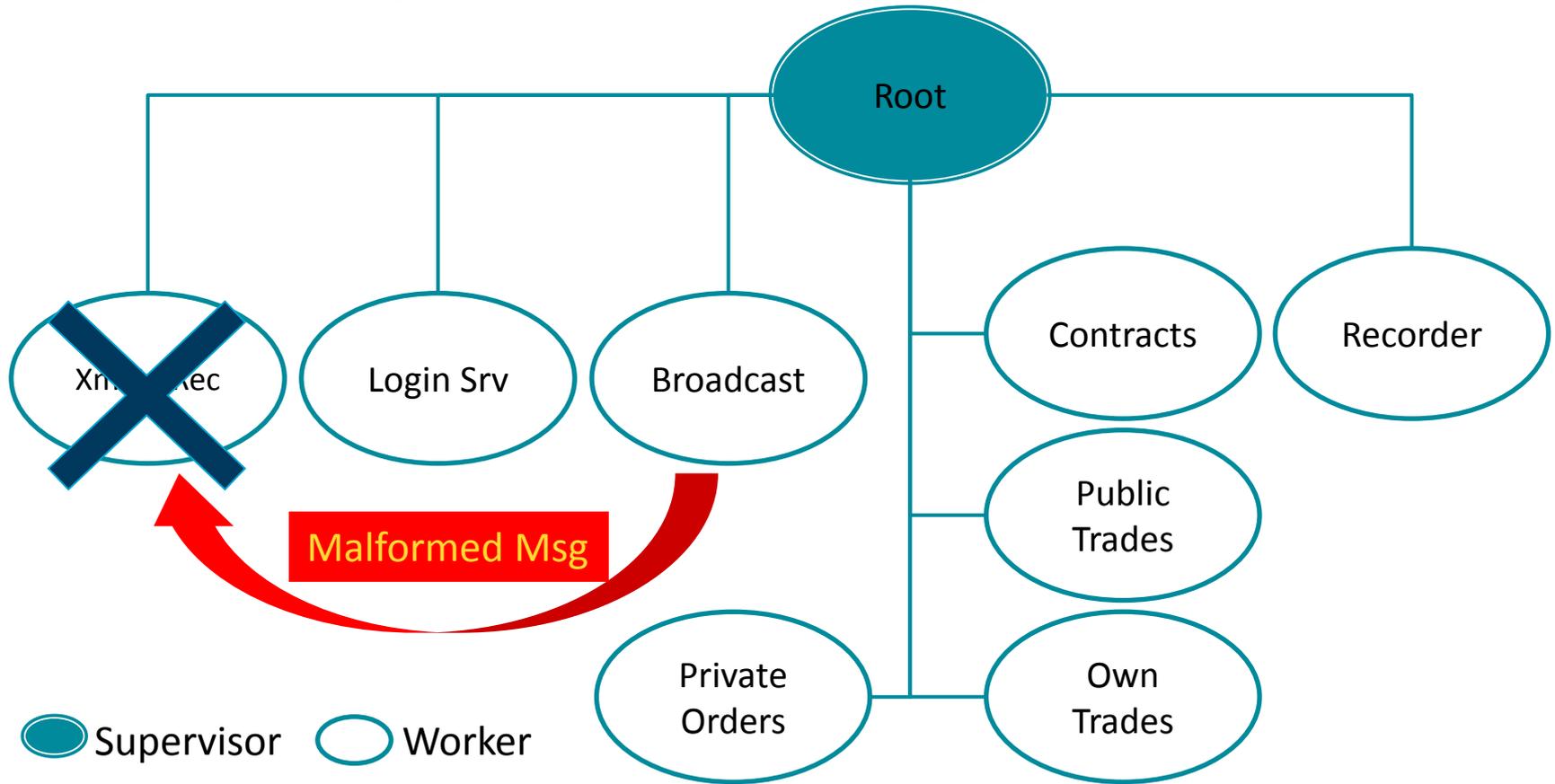
6.3 Core system. Version 0.2



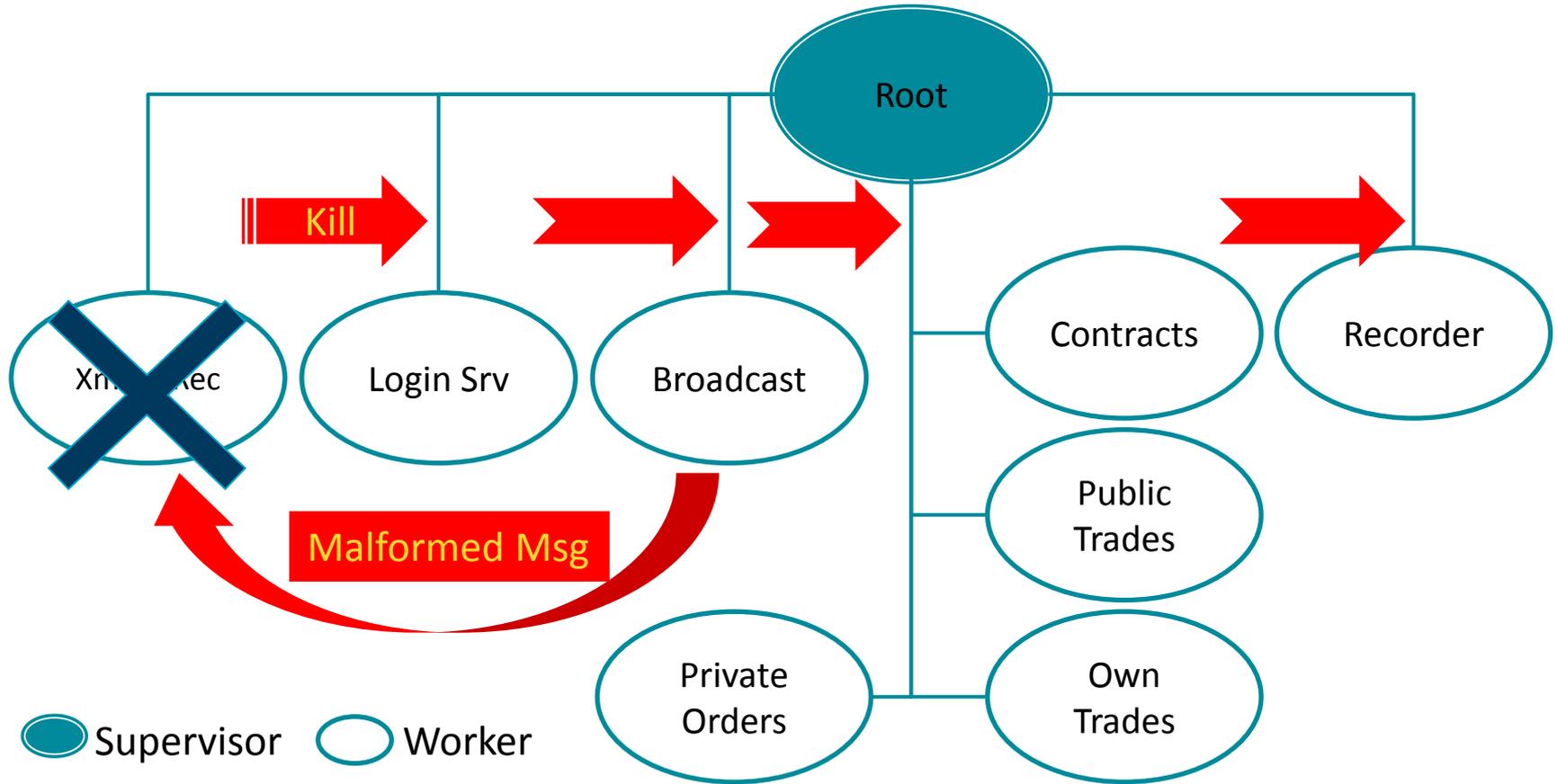
6.3.1 Core system V.0.2. Error processing



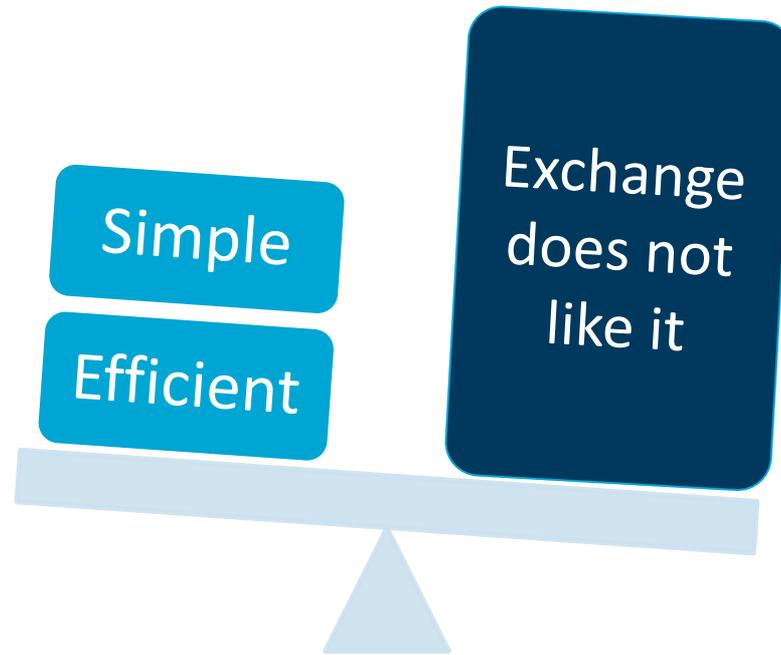
6.3.2 Core system V.0.2. Error processing



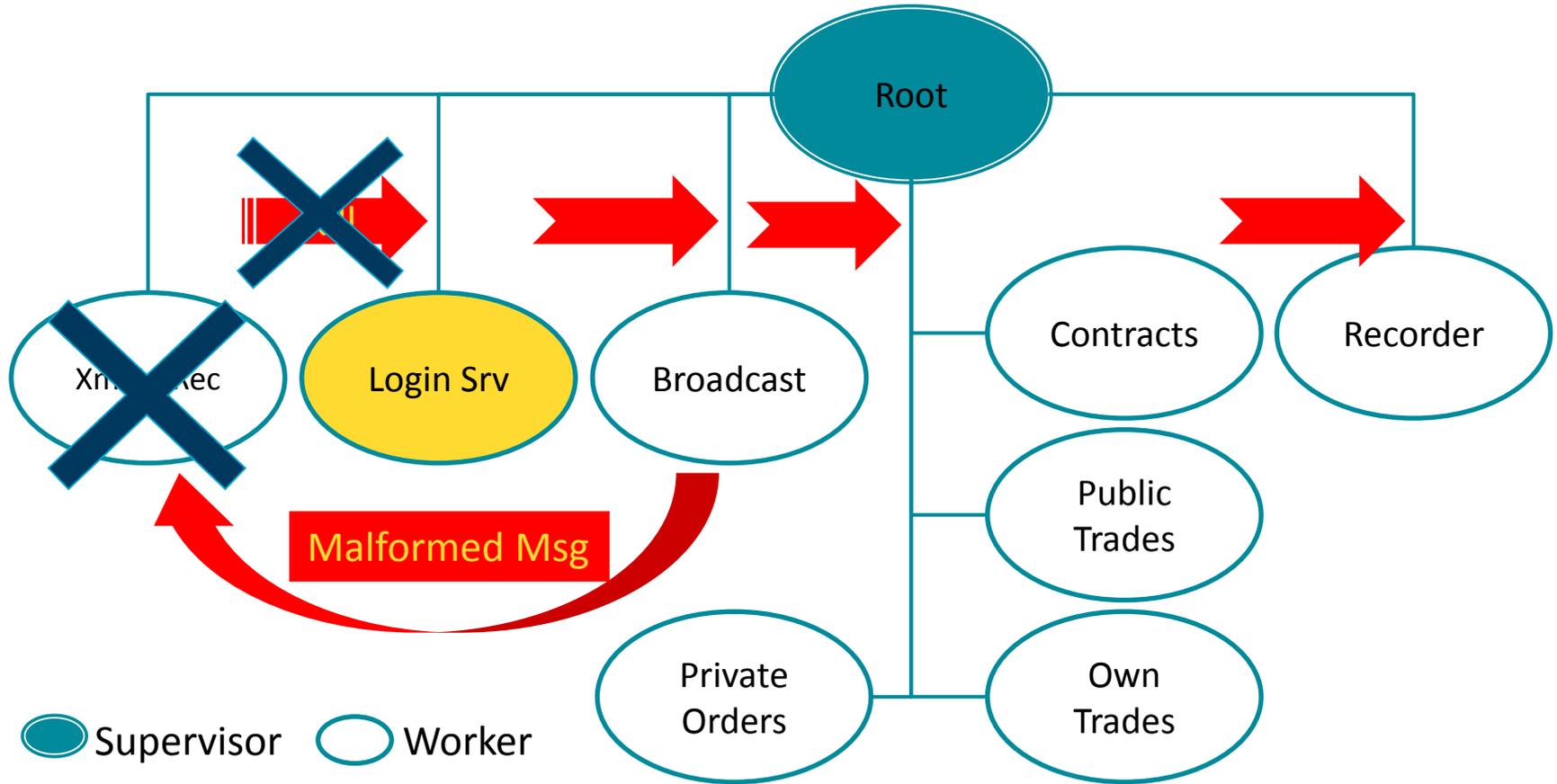
6.3.3 Core system V.0.2. Error processing



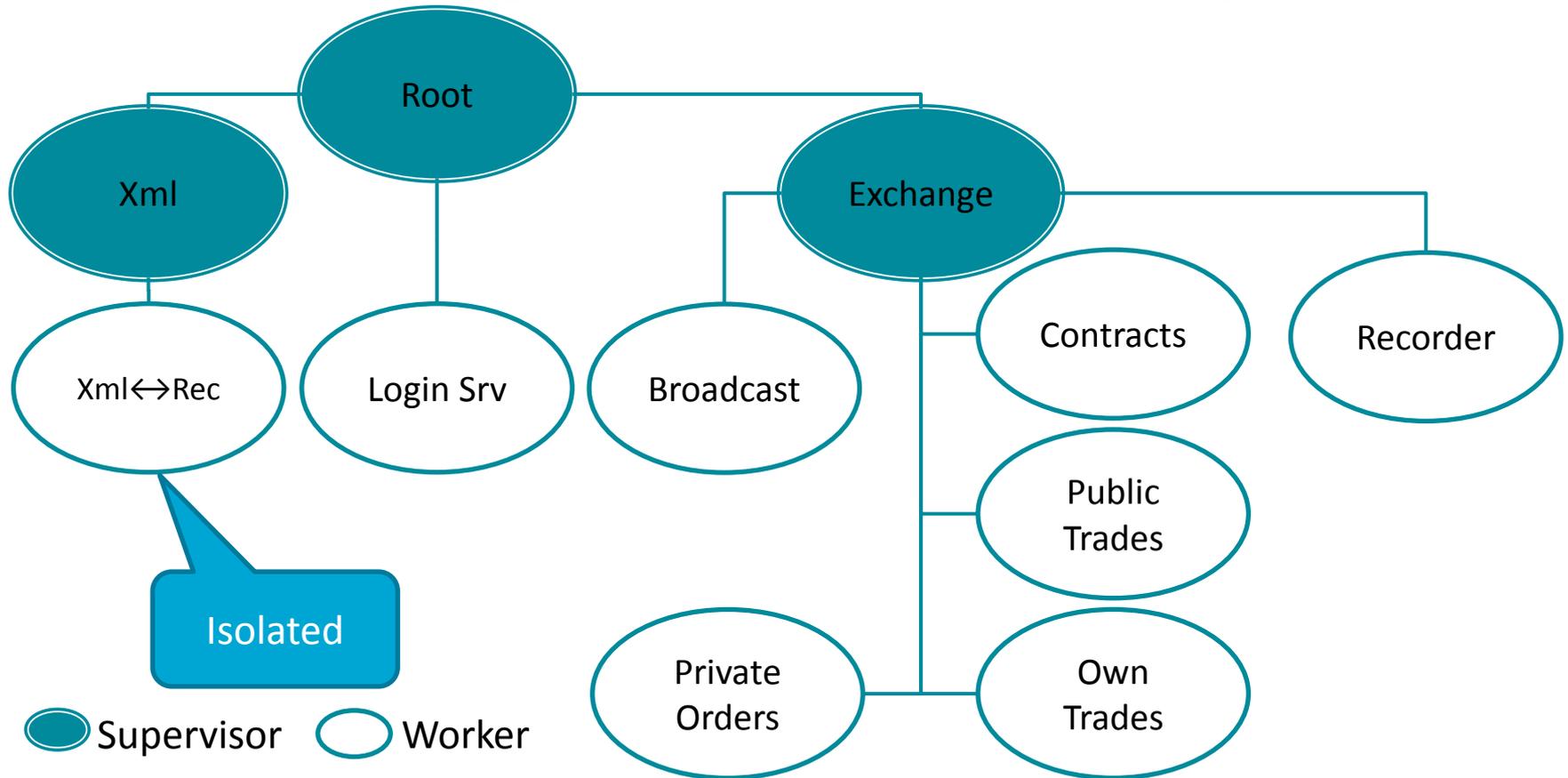
6.3.4 Core system V.0.2. Pro and Cons



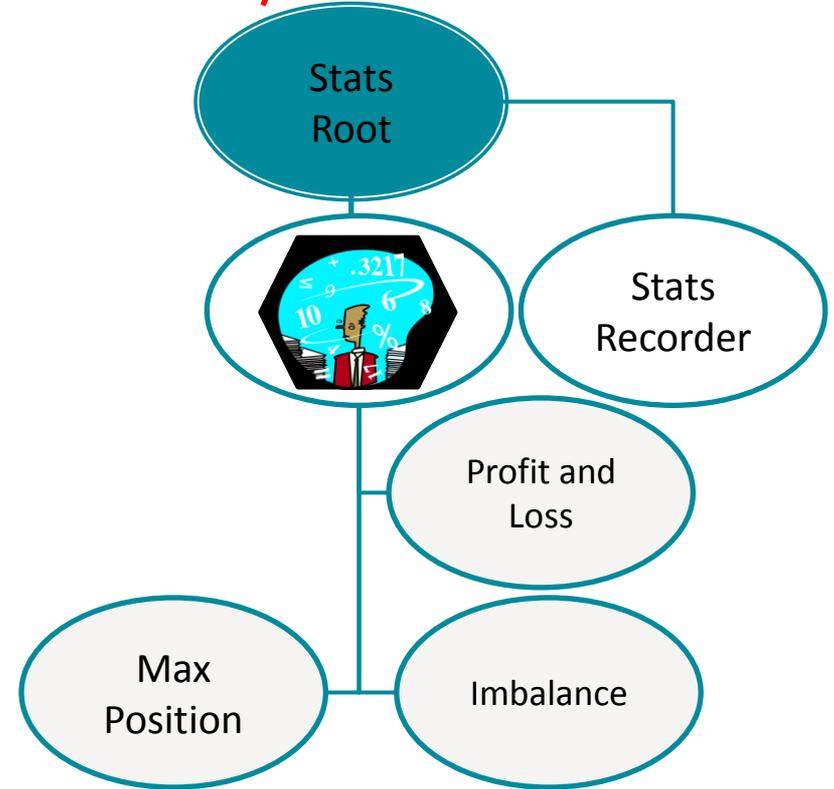
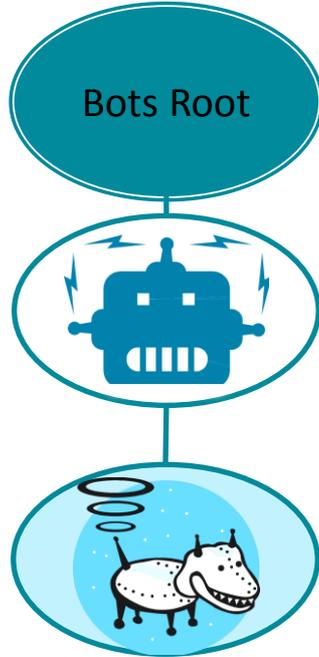
6.3.5 Core system V.0.2. Keep connection alive!



6.3.6 Just change a few lines... Core system V.0.3



6.4 Episode 0.4. Attack of the Bots



Overlord



Bot



Statistics



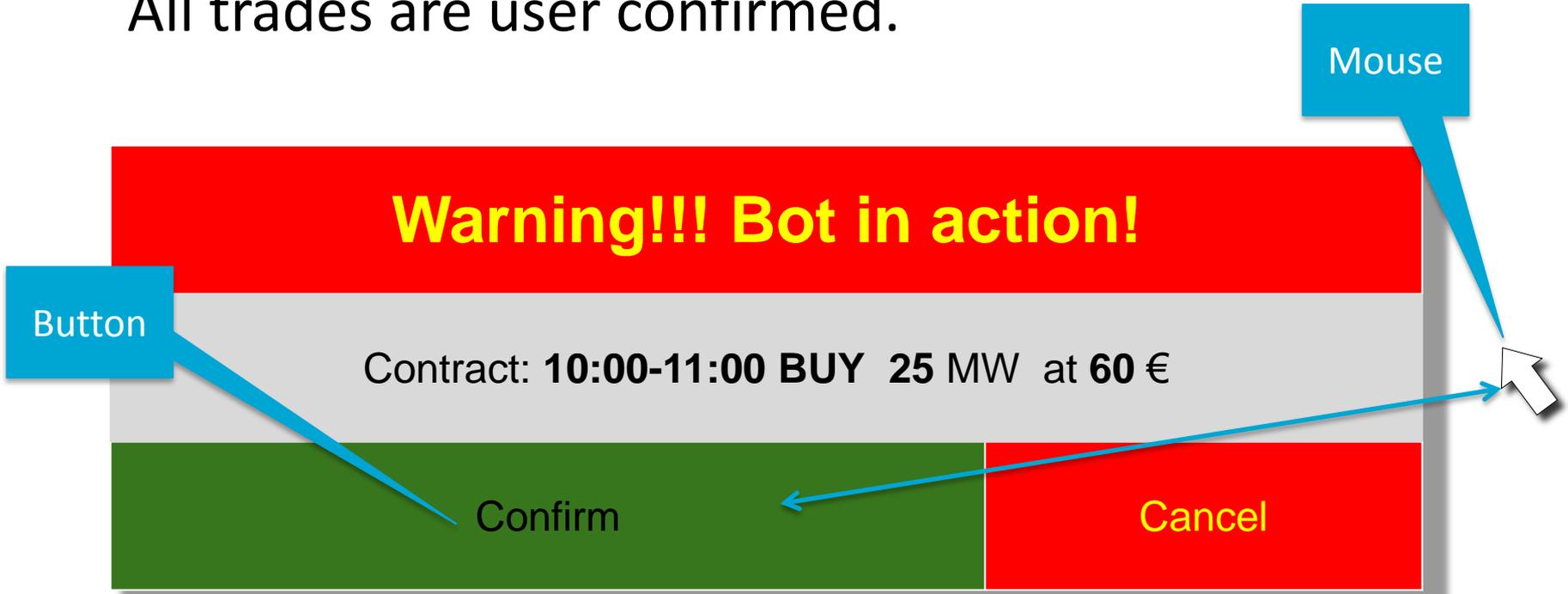
Supervisor



Worker

6.4.1 Episode 0.4. Attack of the bots

Add a “primitive Bot”: “Buy Low – Sell High”
All trades are user confirmed.



6.4.2 Episode 0.4. Attack of the BOOSTED bots

Warning!!! Bot in Action!

Contract: 10:00-11:00 BUY 25 MW at 60 €

Confirm

Cancel

Buzzer: Speed and Fun!



7 Ready for launch? 5,4,3,2,1; ignition...

Mind the Knights...



7.1 Knight Capital: \$440 Mio for the switch....

“There is NO KILL SWITCH;

the minute you hit the send button on an algo it's running and you can't stop it,”

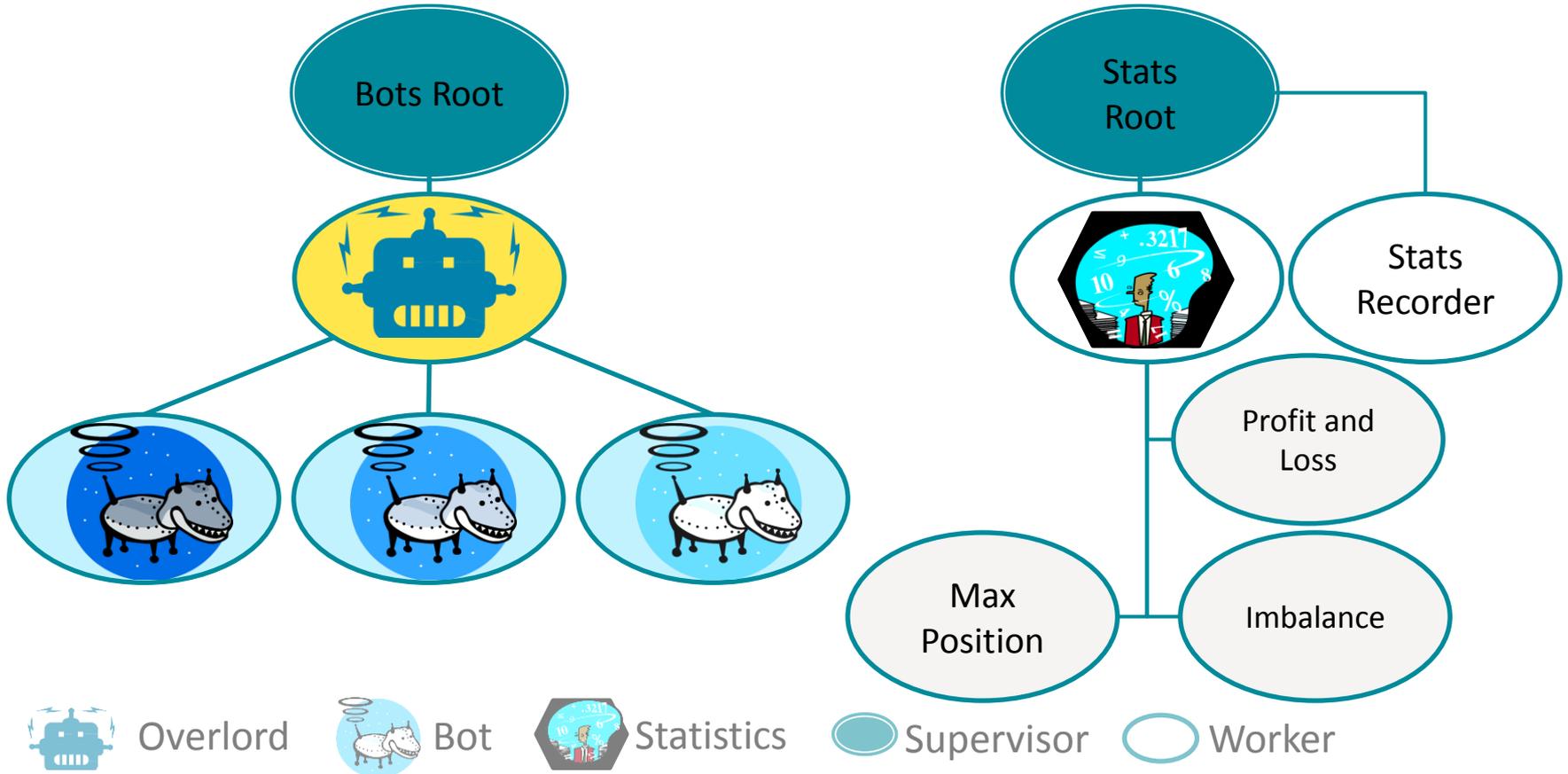
Ken Polcari, managing director at ICAP Equities.

From “HFT traders under fire after algo glitch”

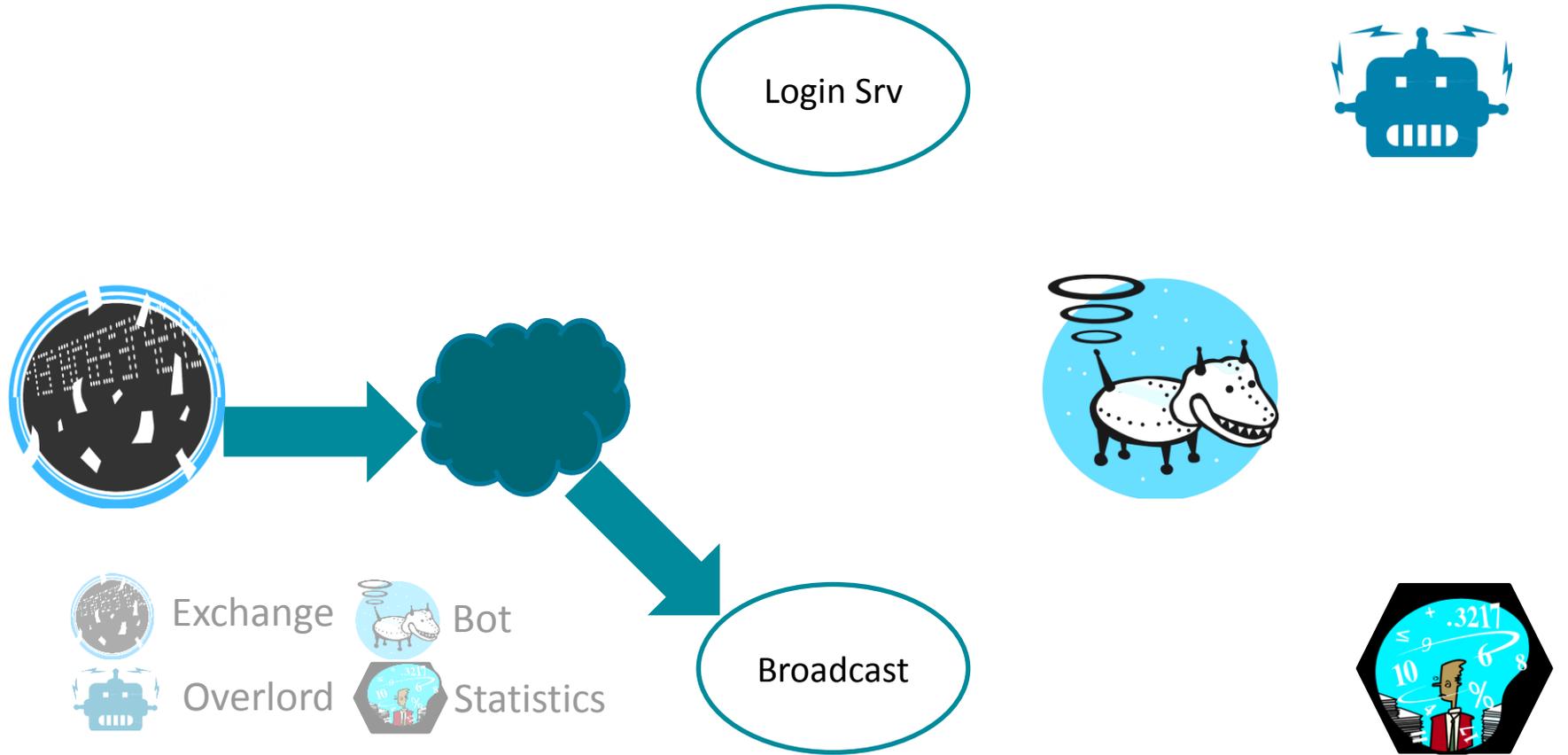
By Michael Mackenzie and Arash Massoudi in New York



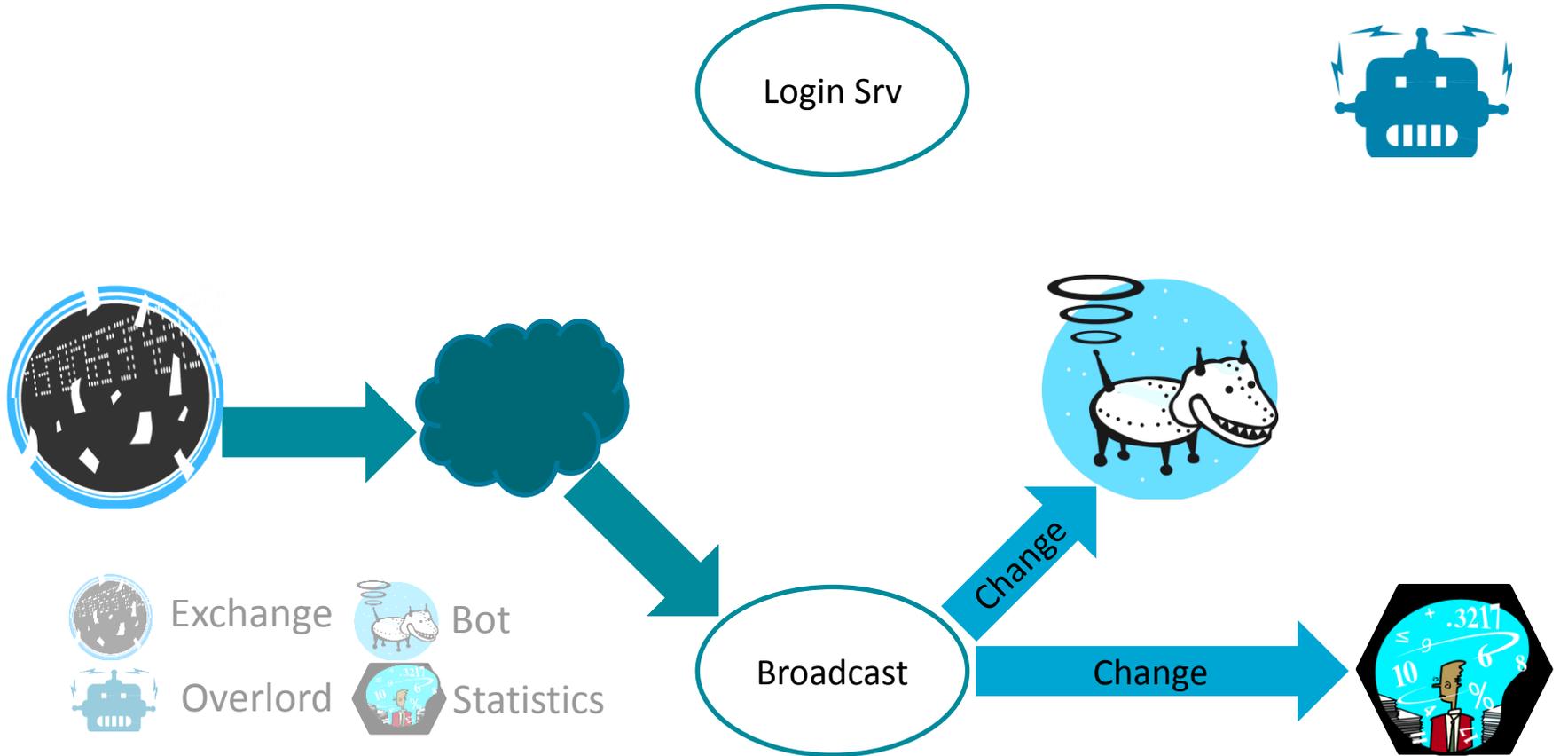
7.2 Overlord will stop the bots!



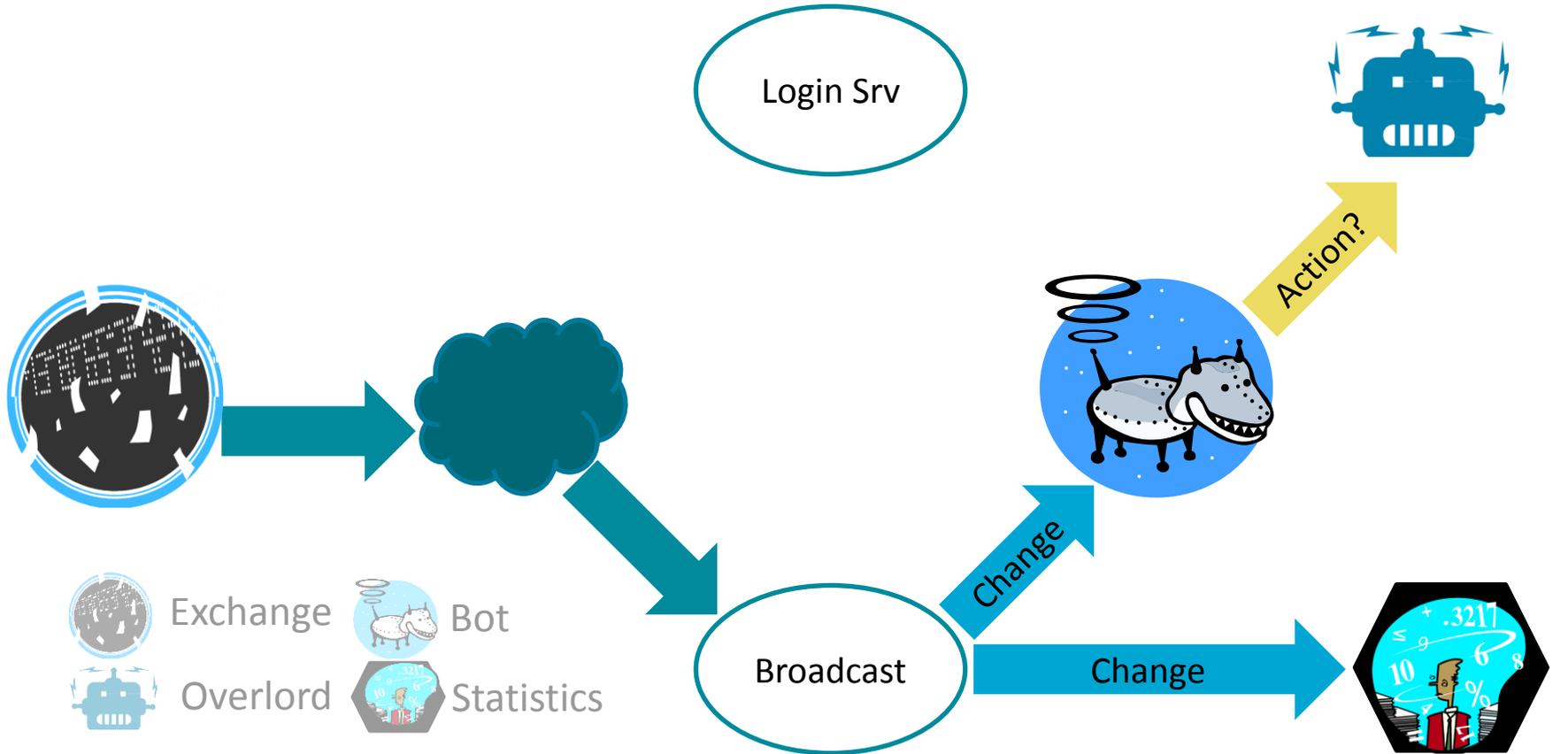
7.3.0 Where is the switch? Step-by-step



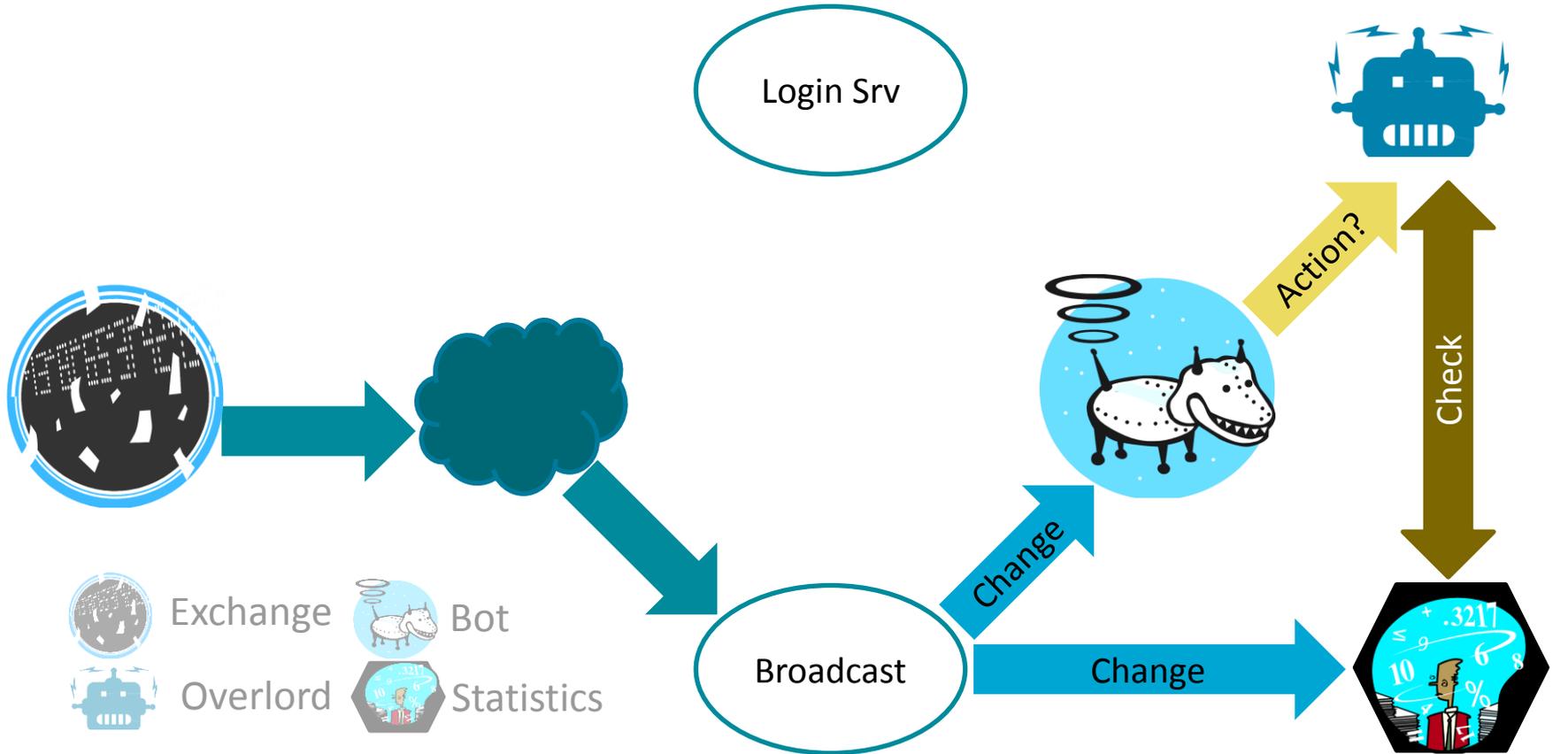
7.3.1 Where is the switch? Step-by-step



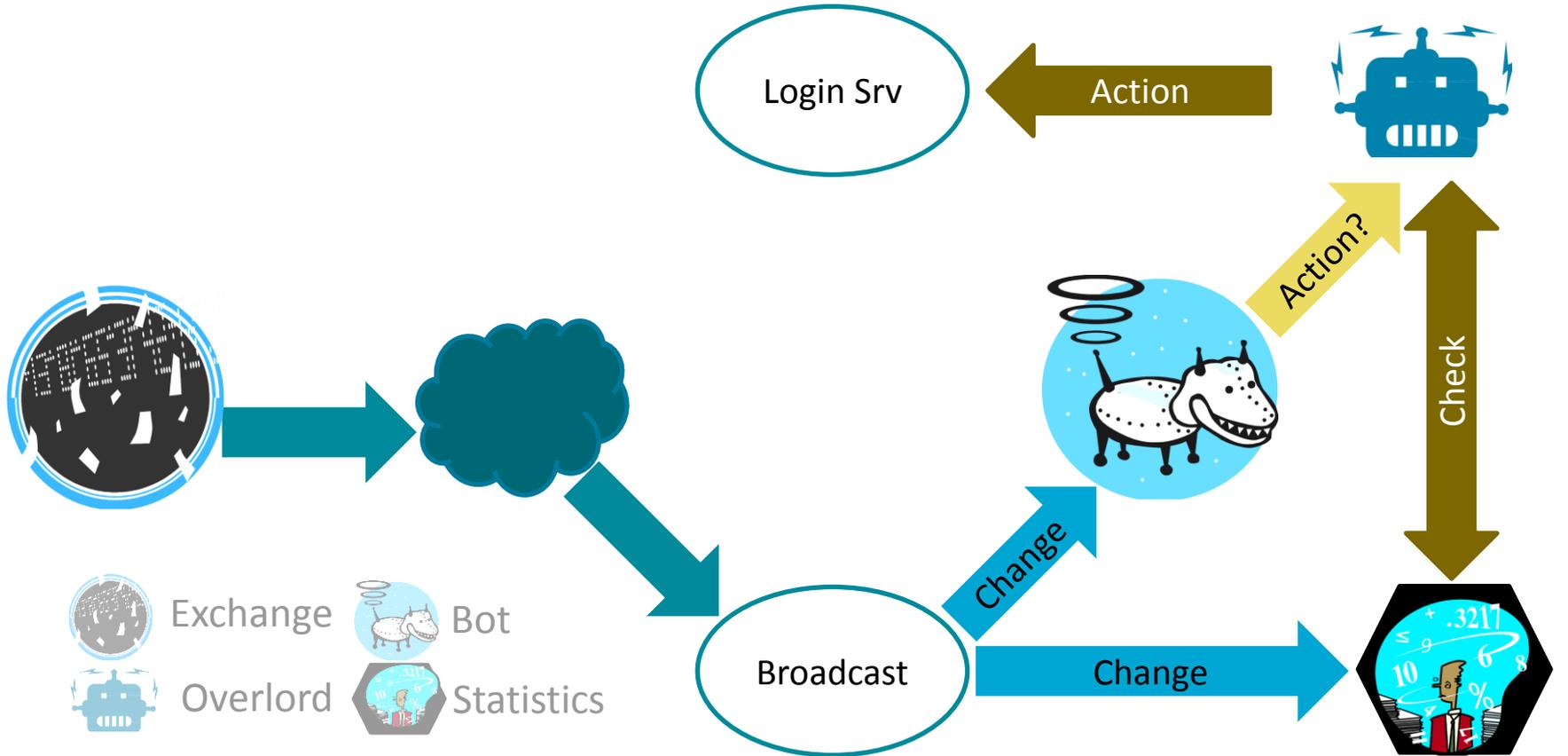
7.3.2 Where is the switch? Step-by-step



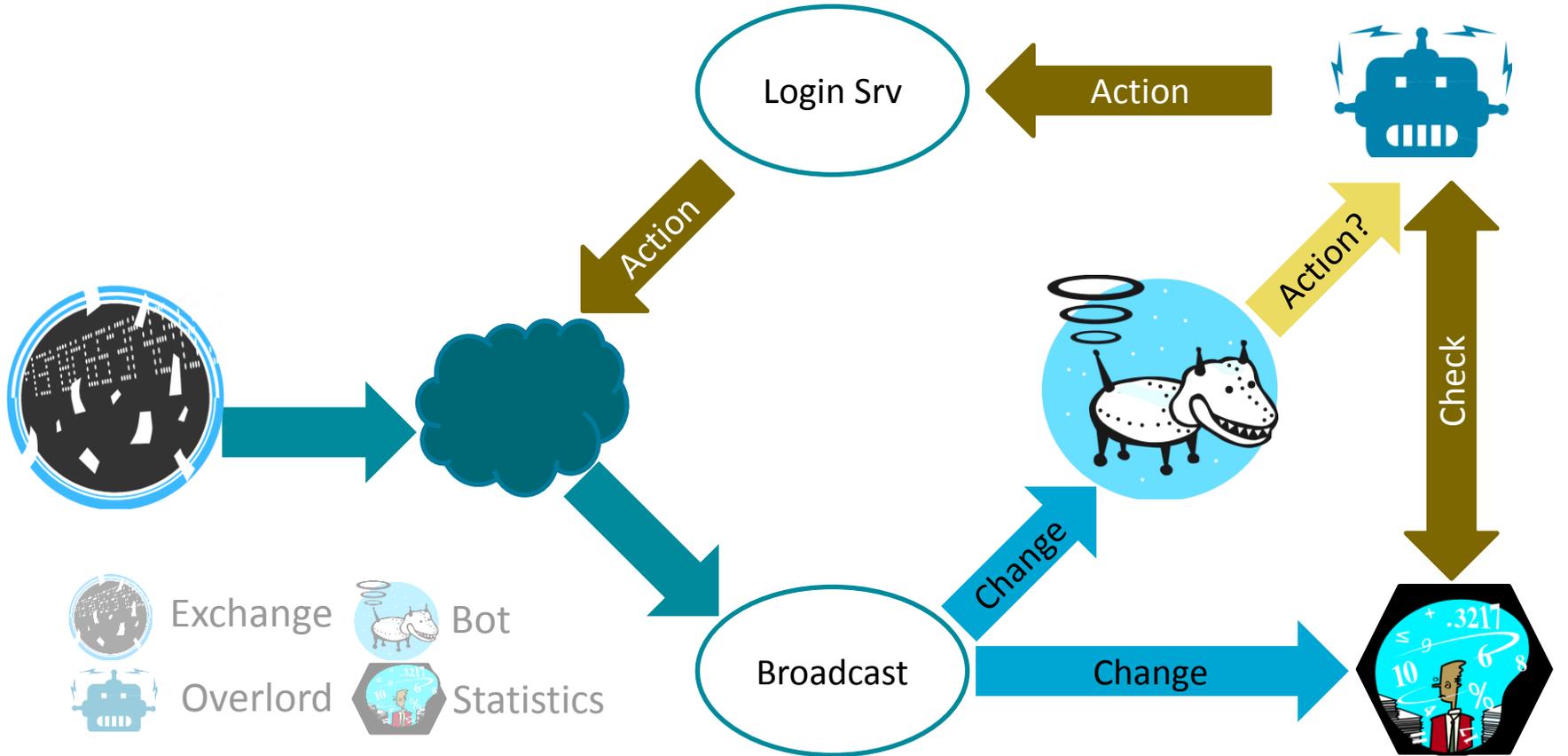
7.3.3 Where is the switch? Step-by-step



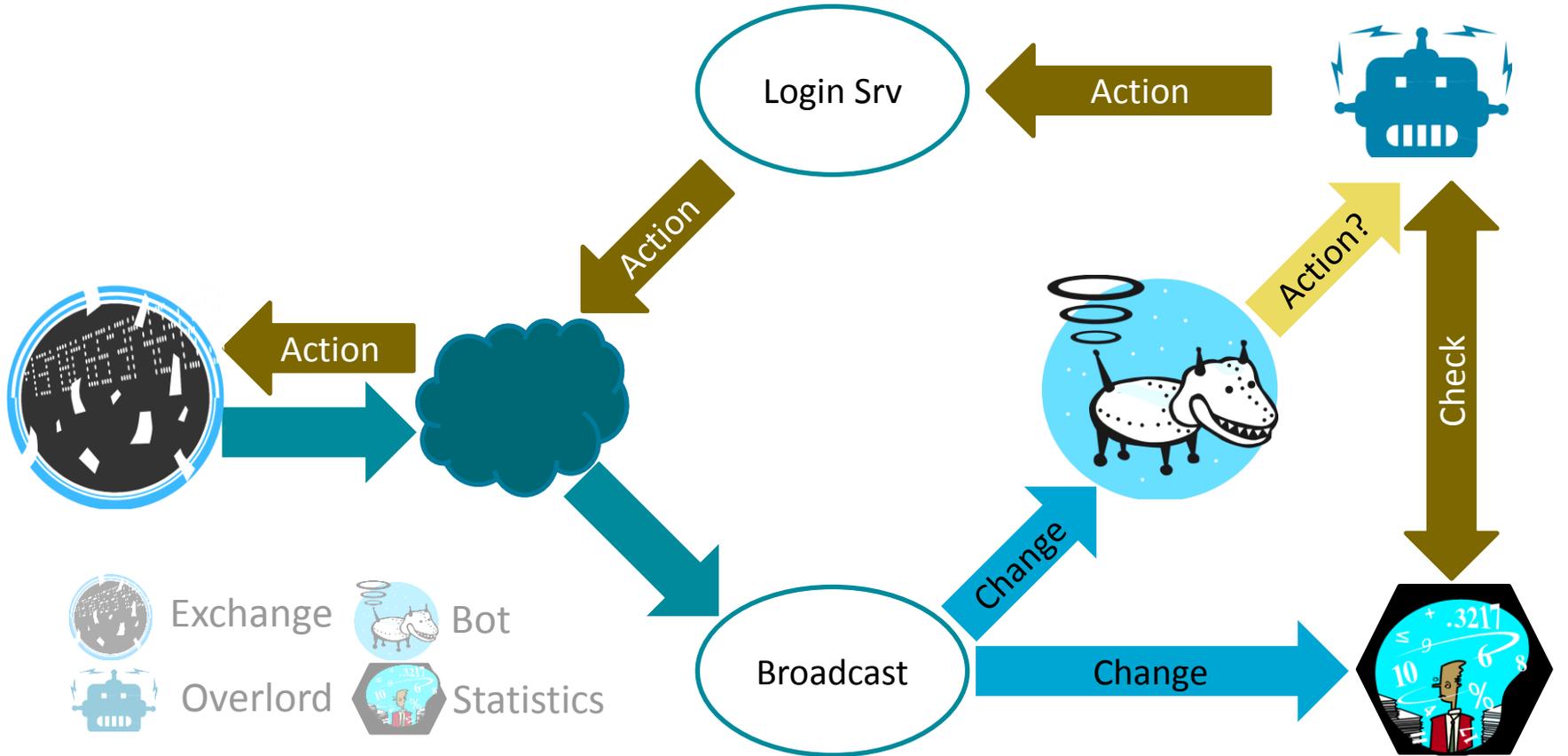
7.3.4 Where is the switch? Step-by-step



7.3.5 Where is the switch? Step-by-step



7.3.6 Where is the switch? Is it over?



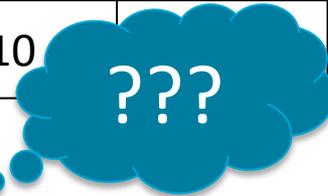
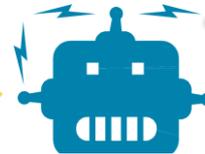
8 A closer look: To trade or not to trade?

Public Orders 10:00-11:00			
Bid		Ask	
MW	€	€	MW
15	20.0€	21.0€	50
30	18.0€	23.0€	10
10	10.0€	30.0€	50

Private Orders			
Contract	Buy/Sell	Volume	Price
09:00-10:00	Buy	10	30.0€
09:00-10:00	Sell	20	35.0€
10:00-11:00	Buy	15	20.0€
11:00-12:00	Sell	10	



10:00-11:00 Sell 10 @ 20.0€



Check



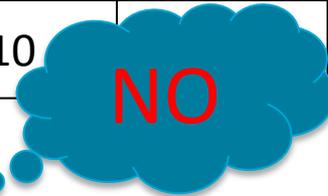
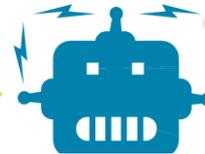
8 A closer look: To trade or not to trade?

Public Orders 10:00-11:00			
Bid		Ask	
MW	€	€	MW
15	20.0€	21.0€	50
30	18.0€	23.0€	10
10	10.0€	30.0€	50

Private Orders			
Contract	Buy/Sell	Volume	Price
09:00-10:00	Buy	10	30.0€
09:00-10:00	Sell	20	35.0€
10:00-11:00	Buy	15	20.0€
11:00-12:00	Sell	10	



10:00-11:00 Sell 10 @ 20.0€



Check



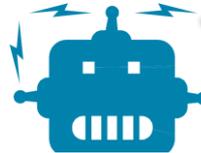
8 A closer look: Not to ...

Public Orders 10:00-11:00			
Bid		Ask	
MW	€	€	MW
15	20.0€	21.0€	50
30	18.0€	23.0€	10
10	10.0€	30.0€	50

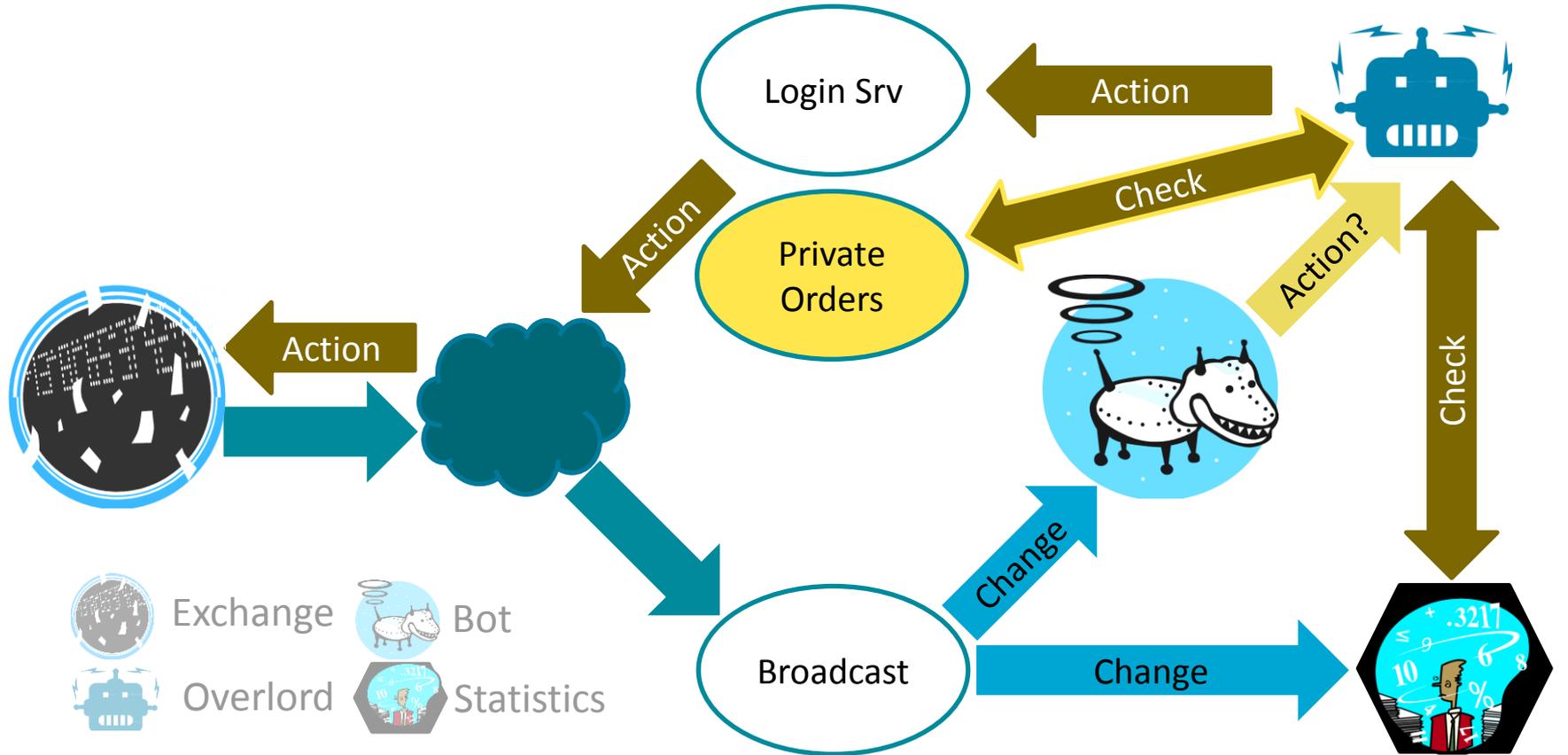
Private Orders			
Contract	Buy/Sell	Volume	Price
09:00-10:00	Buy	10	30.0€
09:00-10:00	Sell	20	35.0€
10:00-11:00	Buy	15	20.0€
11:00-12:00	Sell	10	



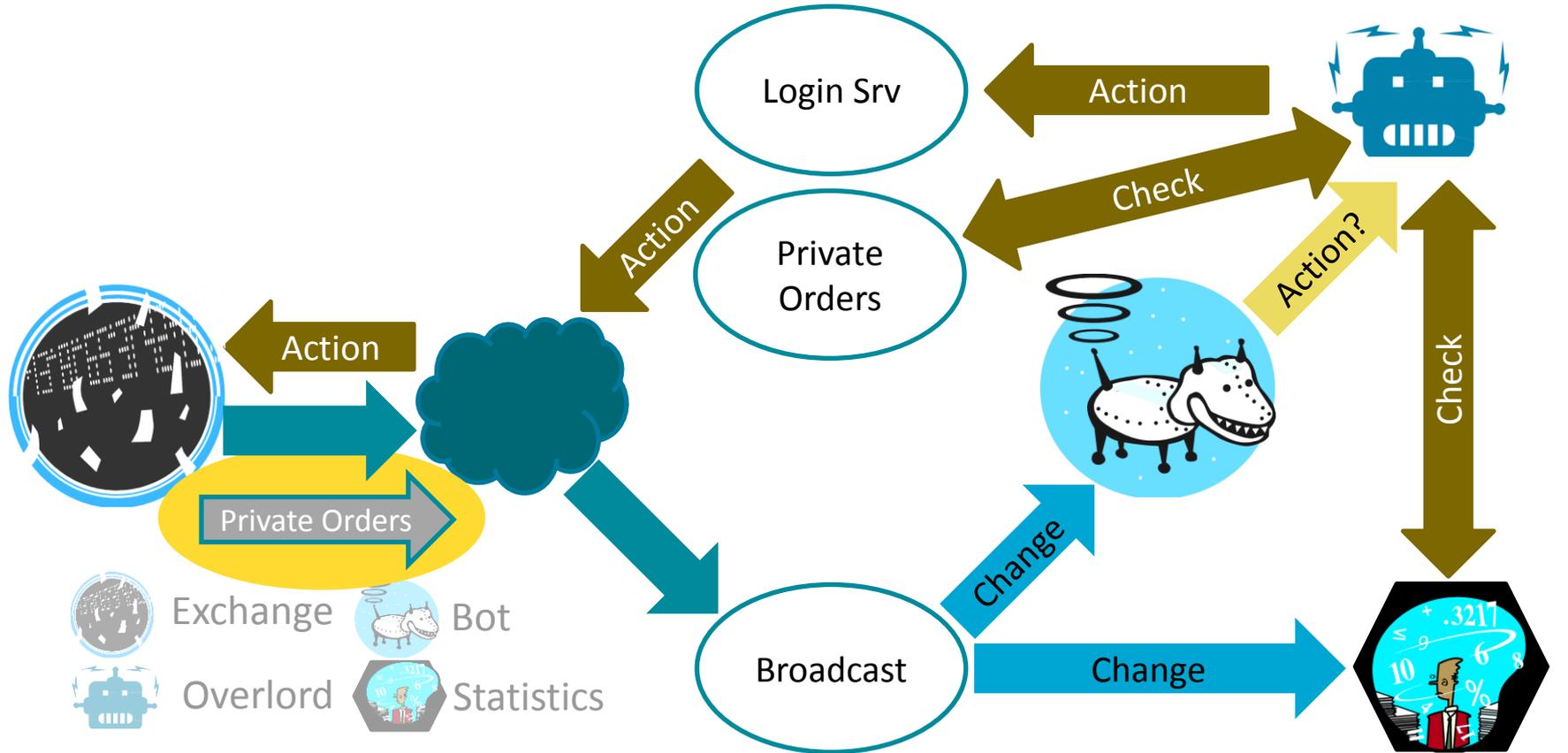
10:00-11:00 Sell 10 @ 20.0€



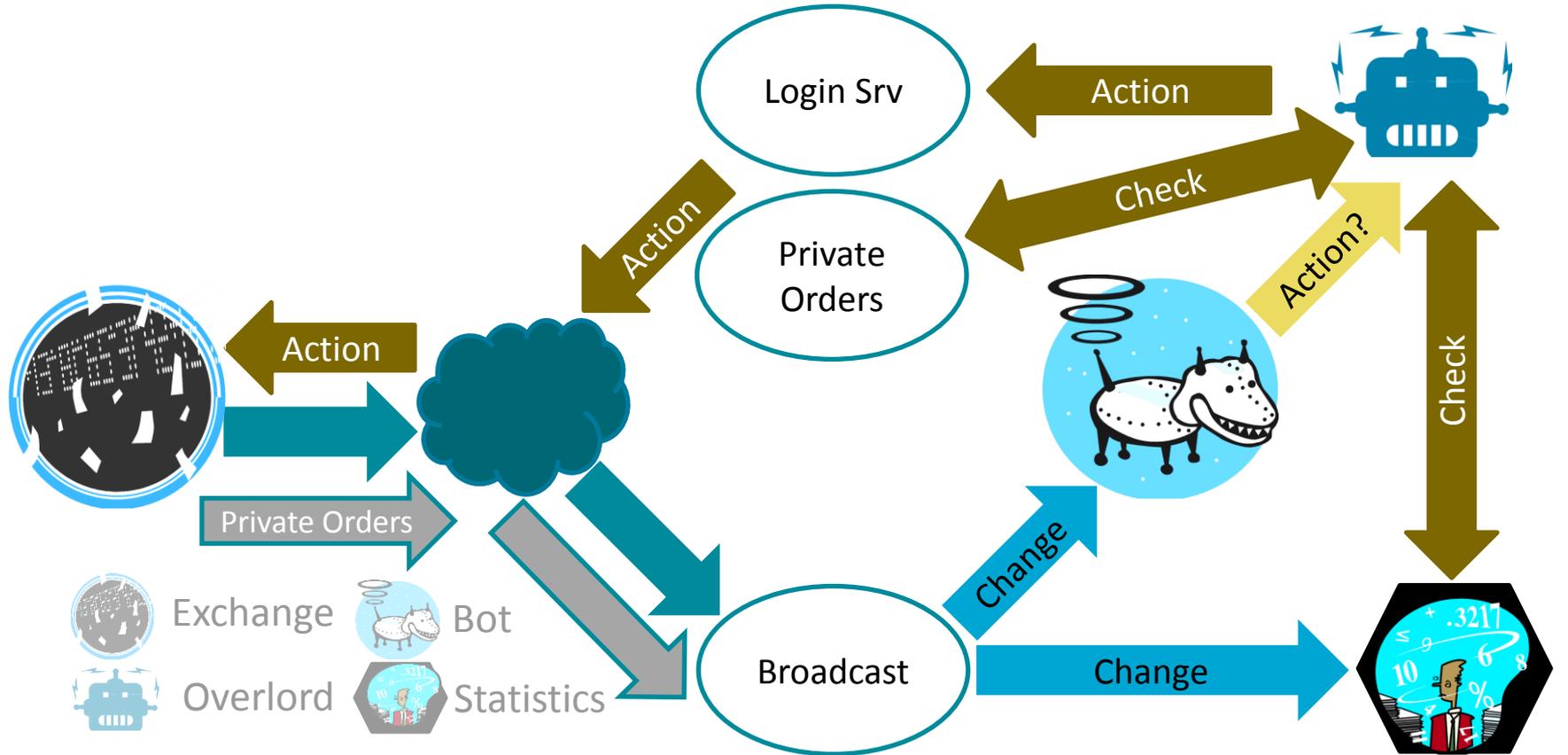
8.1 Do not trade your own orders



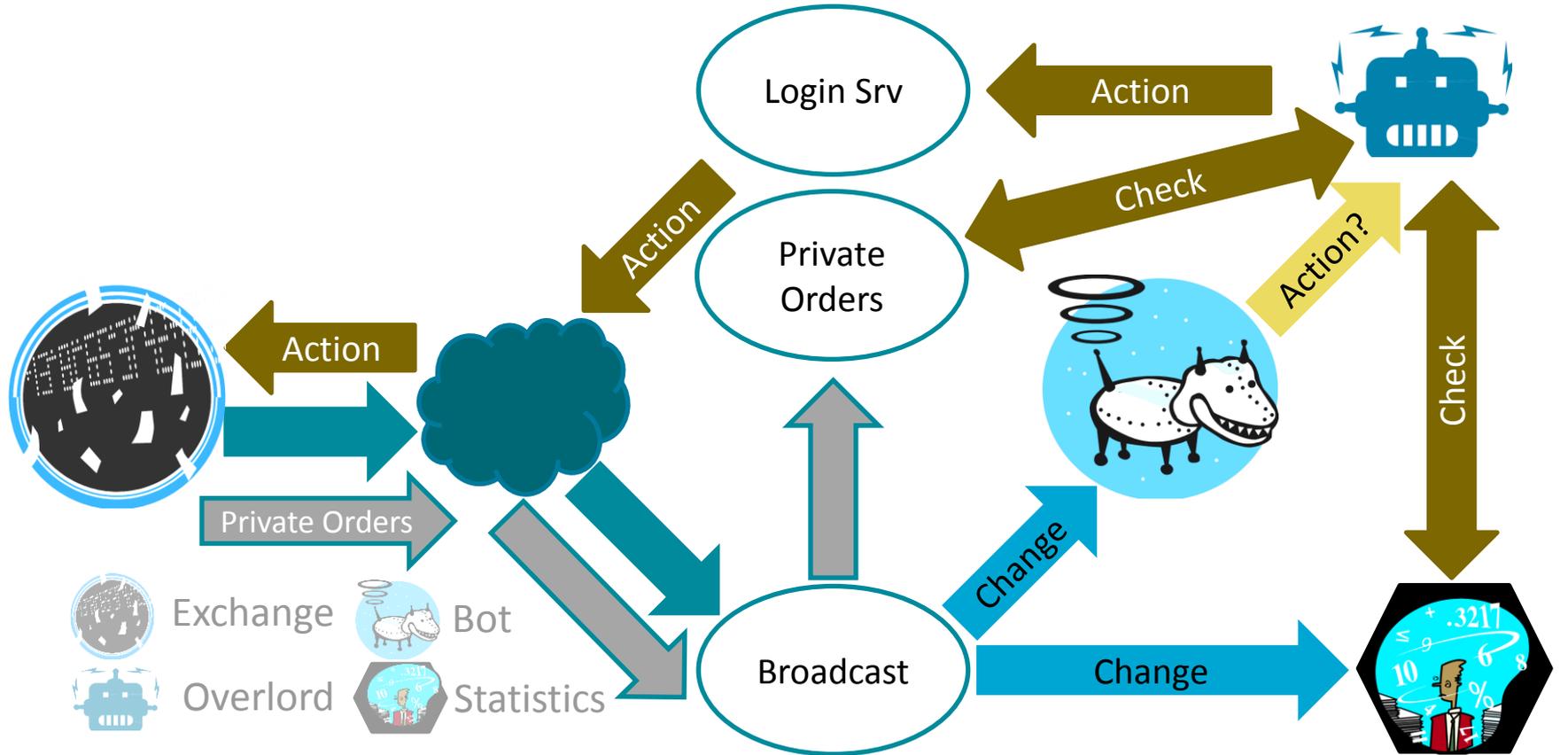
8.2 Do not trade your own orders



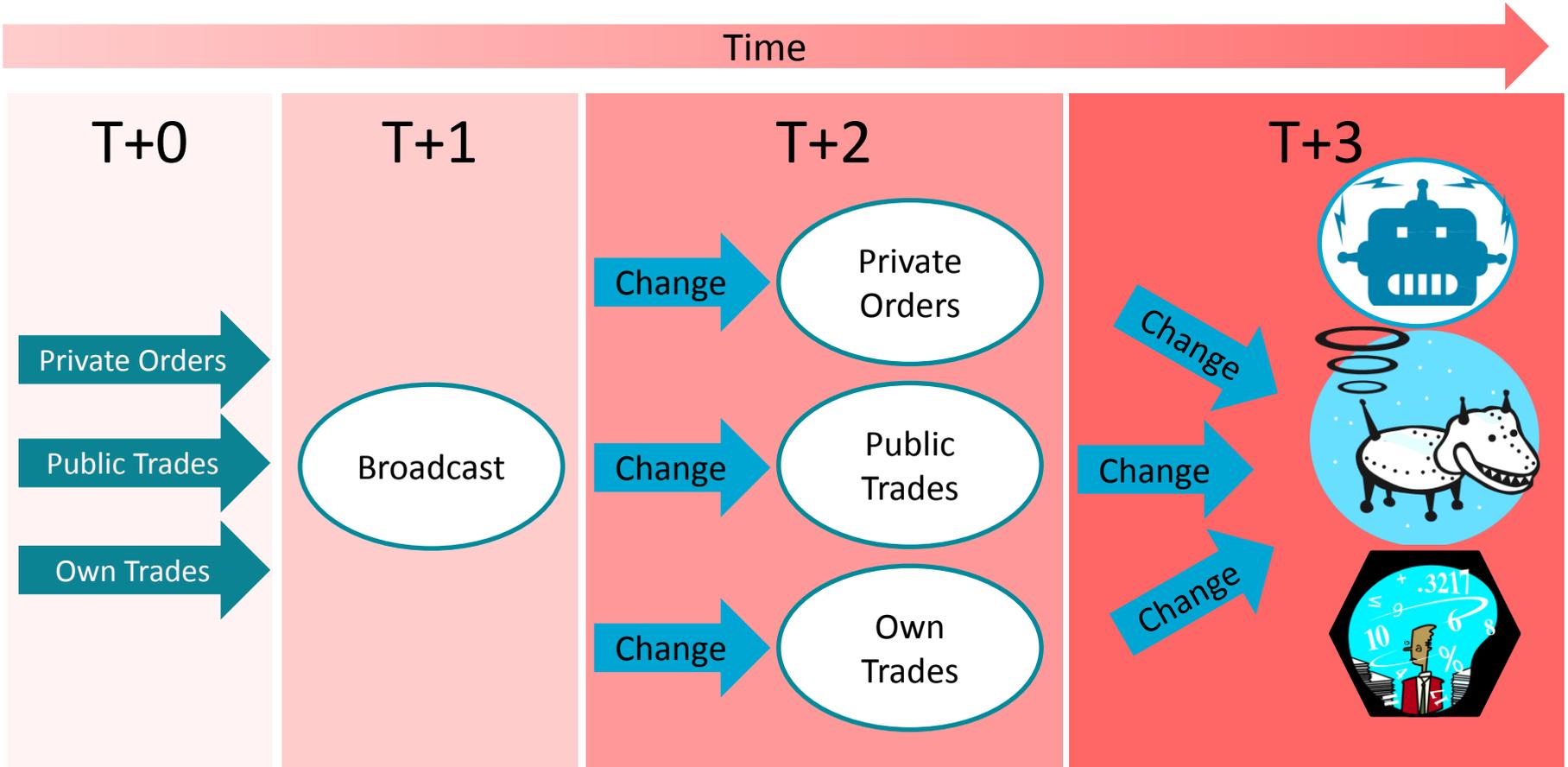
8.3 Do not trade your own orders



8.4 Do not trade your own orders. Done?



9.0 Mind the Time: An Ideal World



9.1 Mind the Time. The Real World

Time

T+0...M

T+1...N

Private Orders

Public Trades

Own Trades

Broadcast

Private Orders

Public Trades

Own Trades

Change

Change

Change

Change

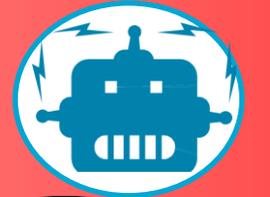
Change

Change

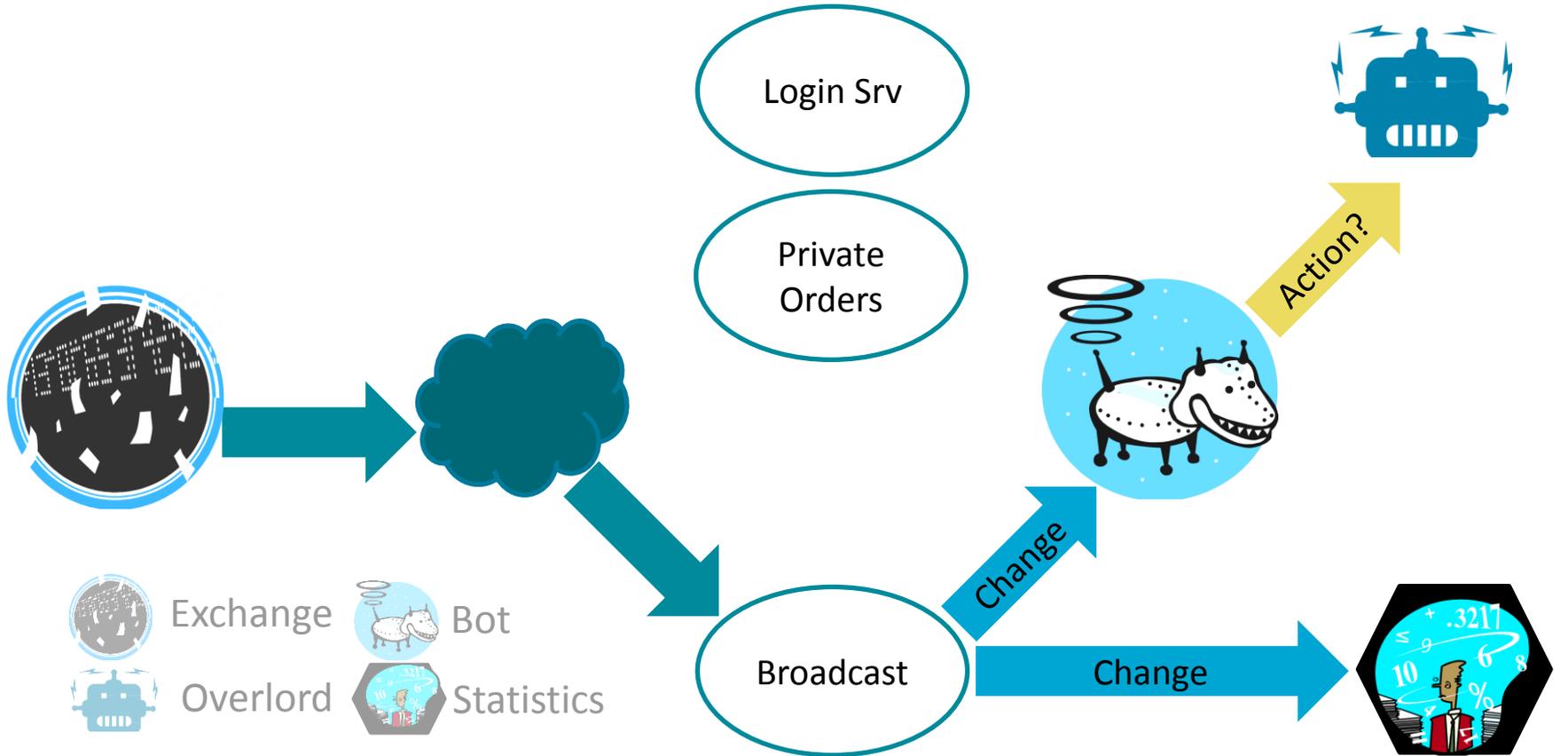
Change

Change

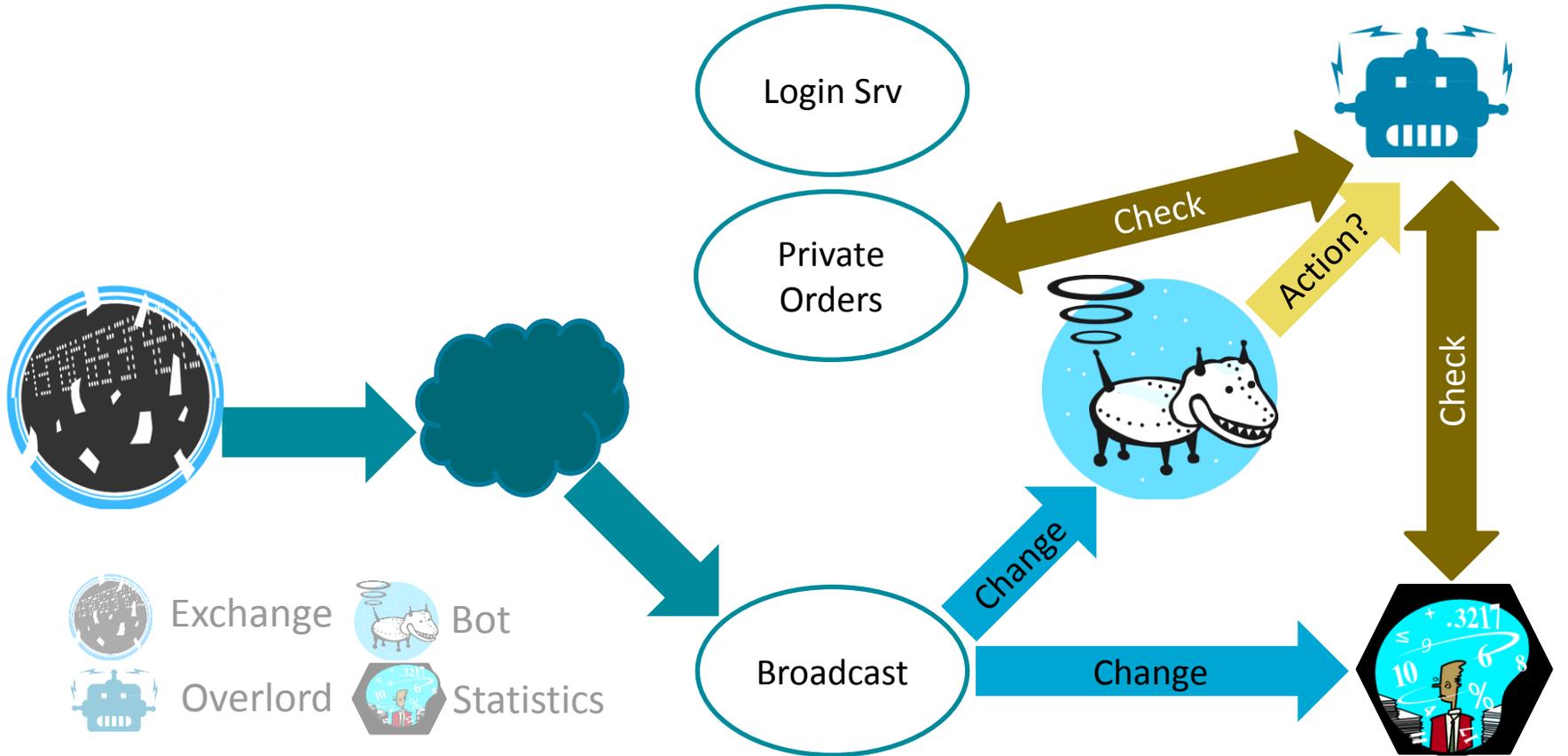
Change



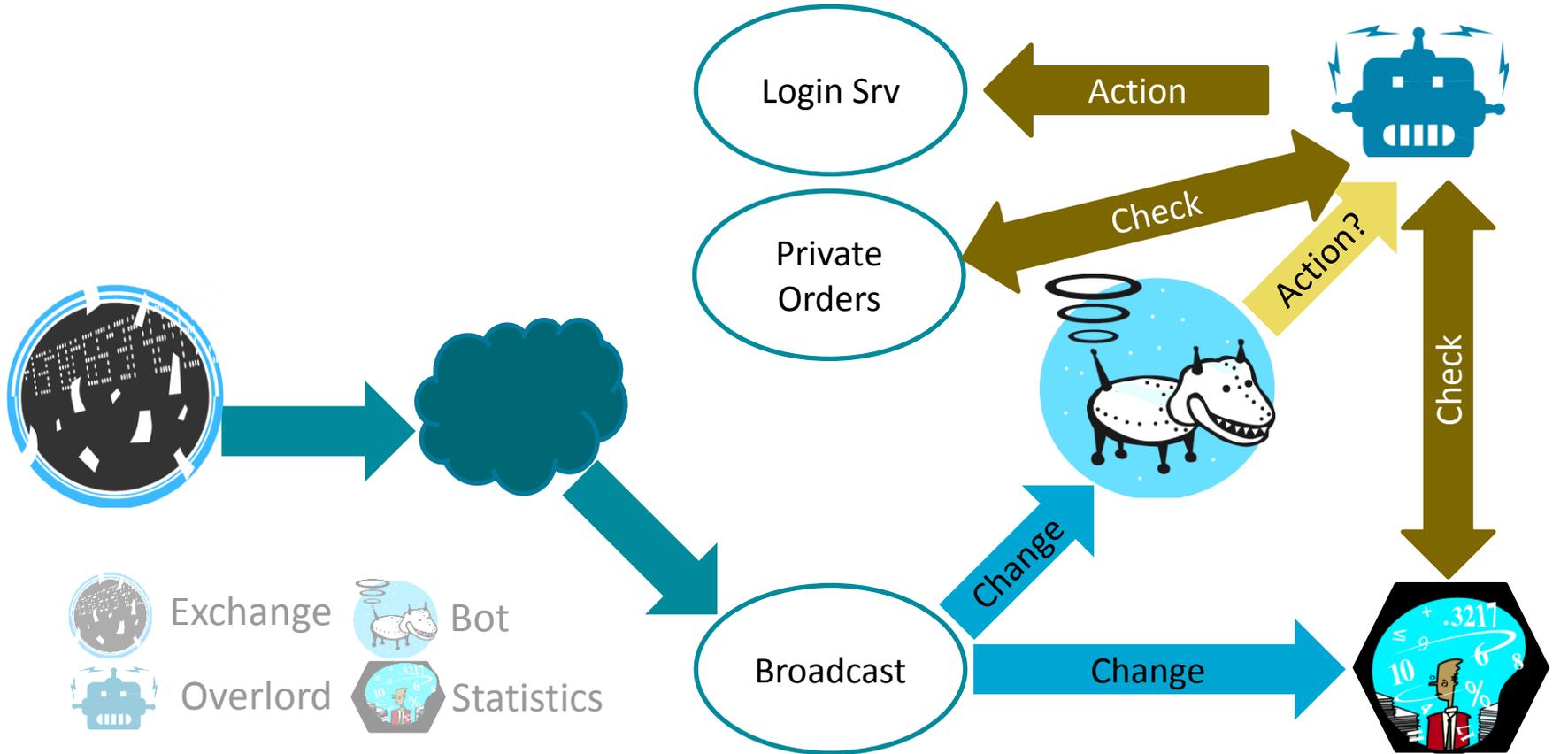
9.2.0 Dealing with the Real World



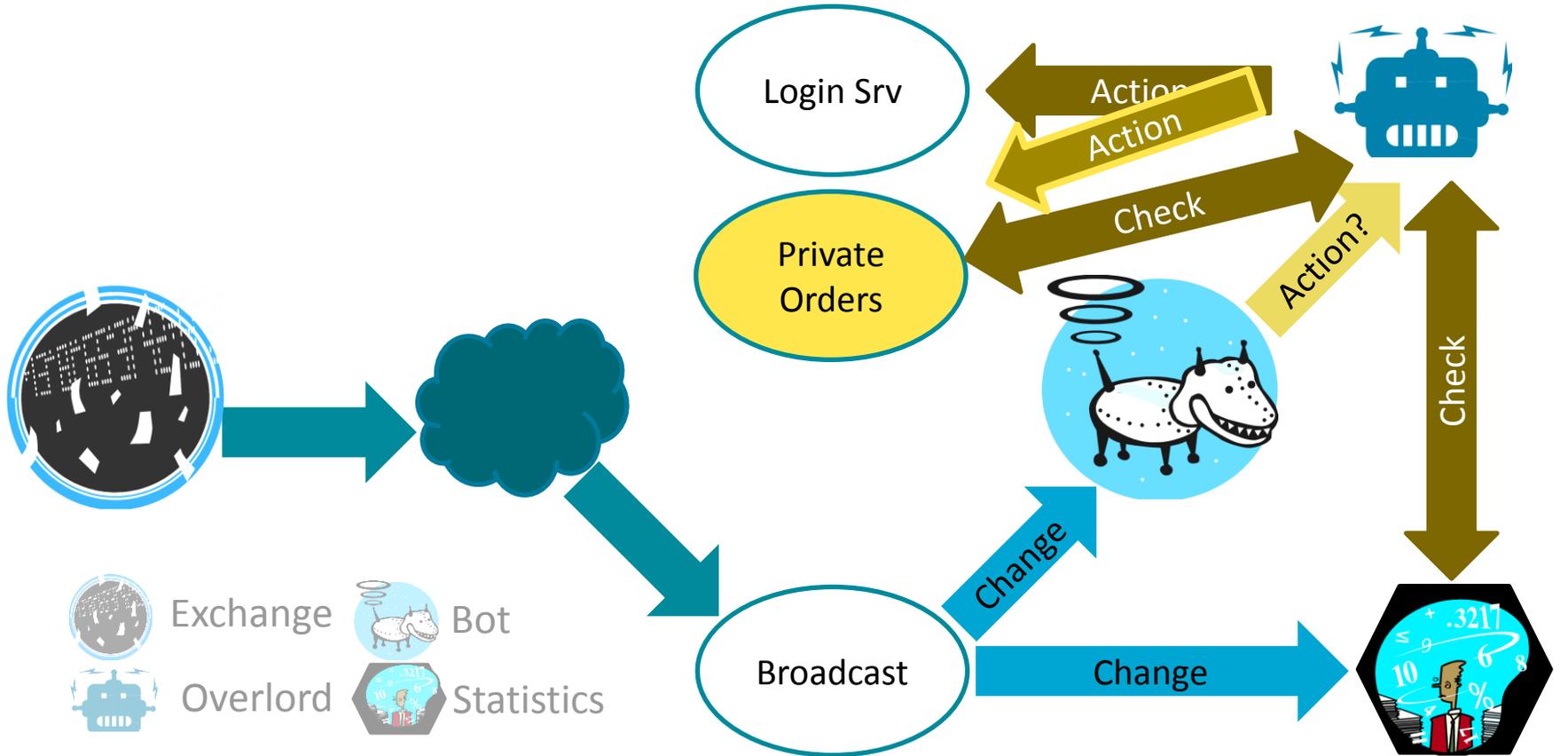
9.2.1 Dealing with the Real World



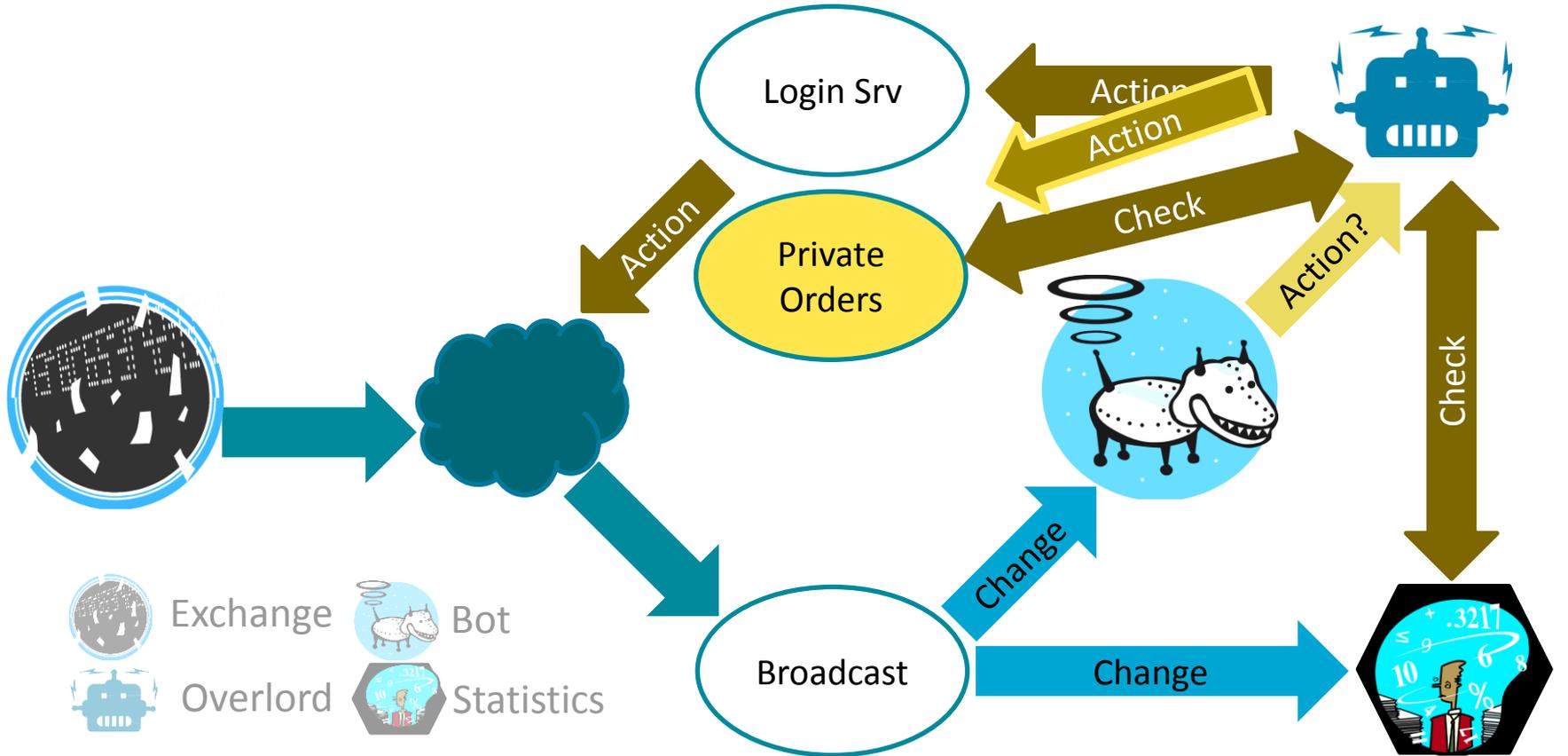
9.2.2 Dealing with the Real World



9.2.3 Dealing with the Real World. Magic is here

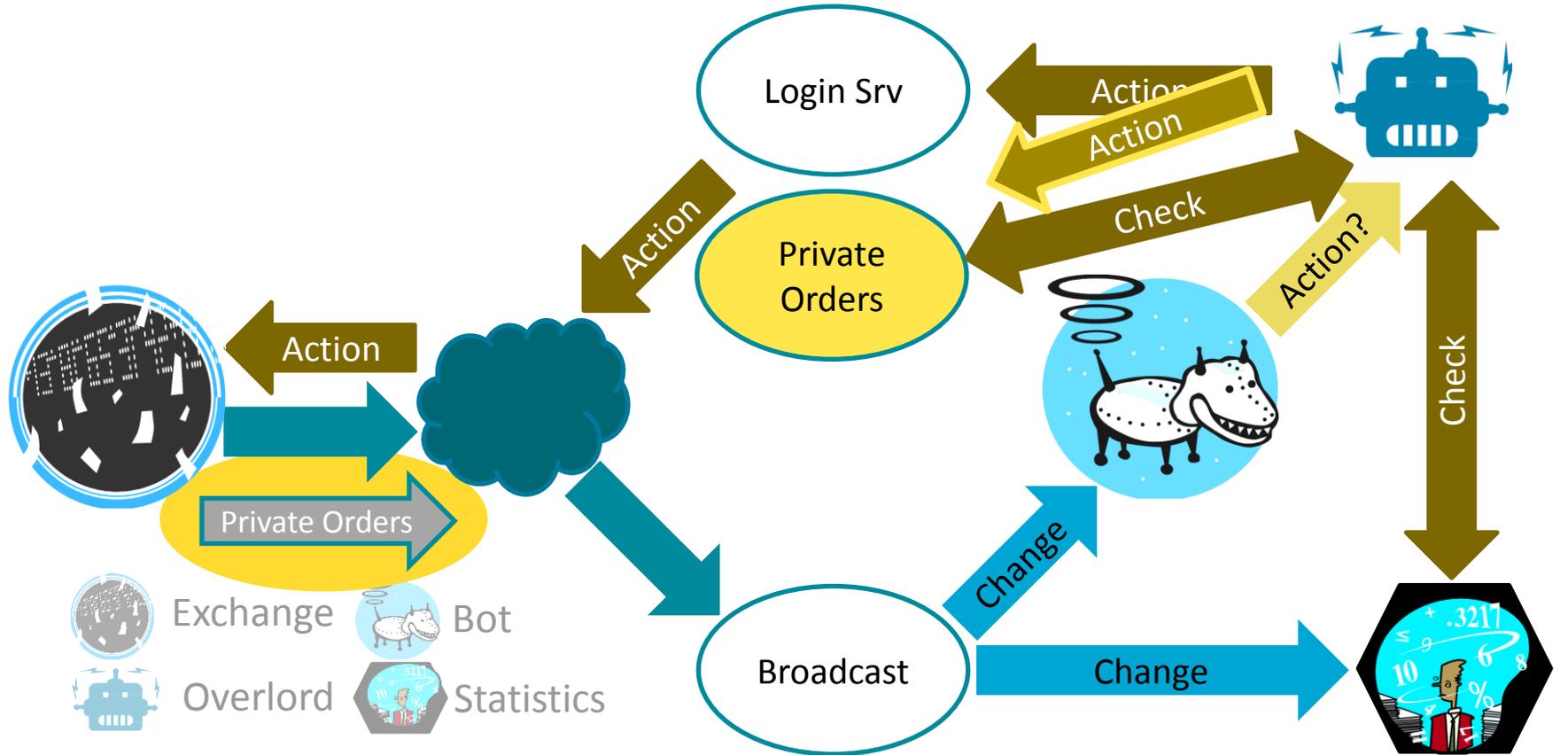


9.2.4 Dealing with the Real World. Magic is here

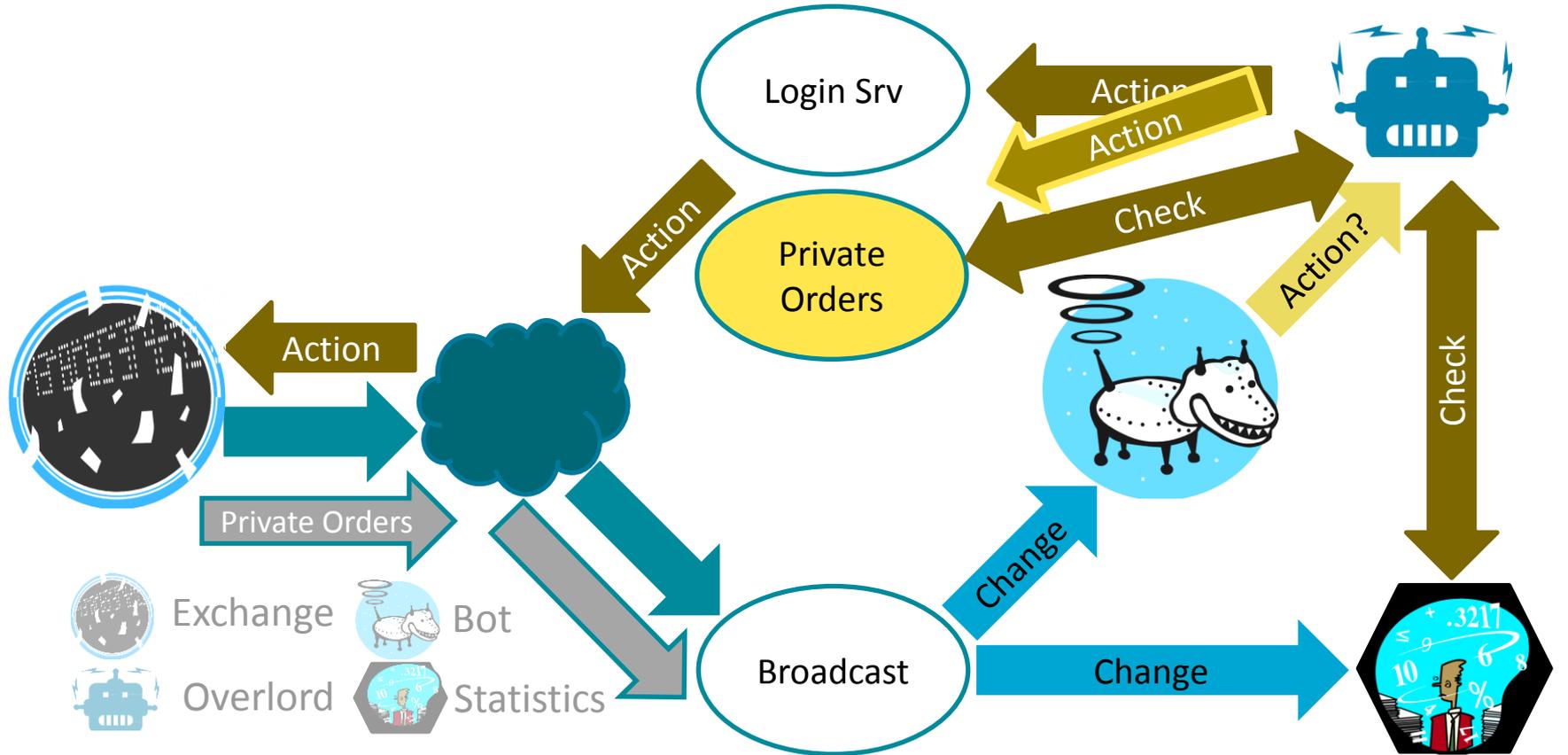


9.2.5 Dealing with the Real World.

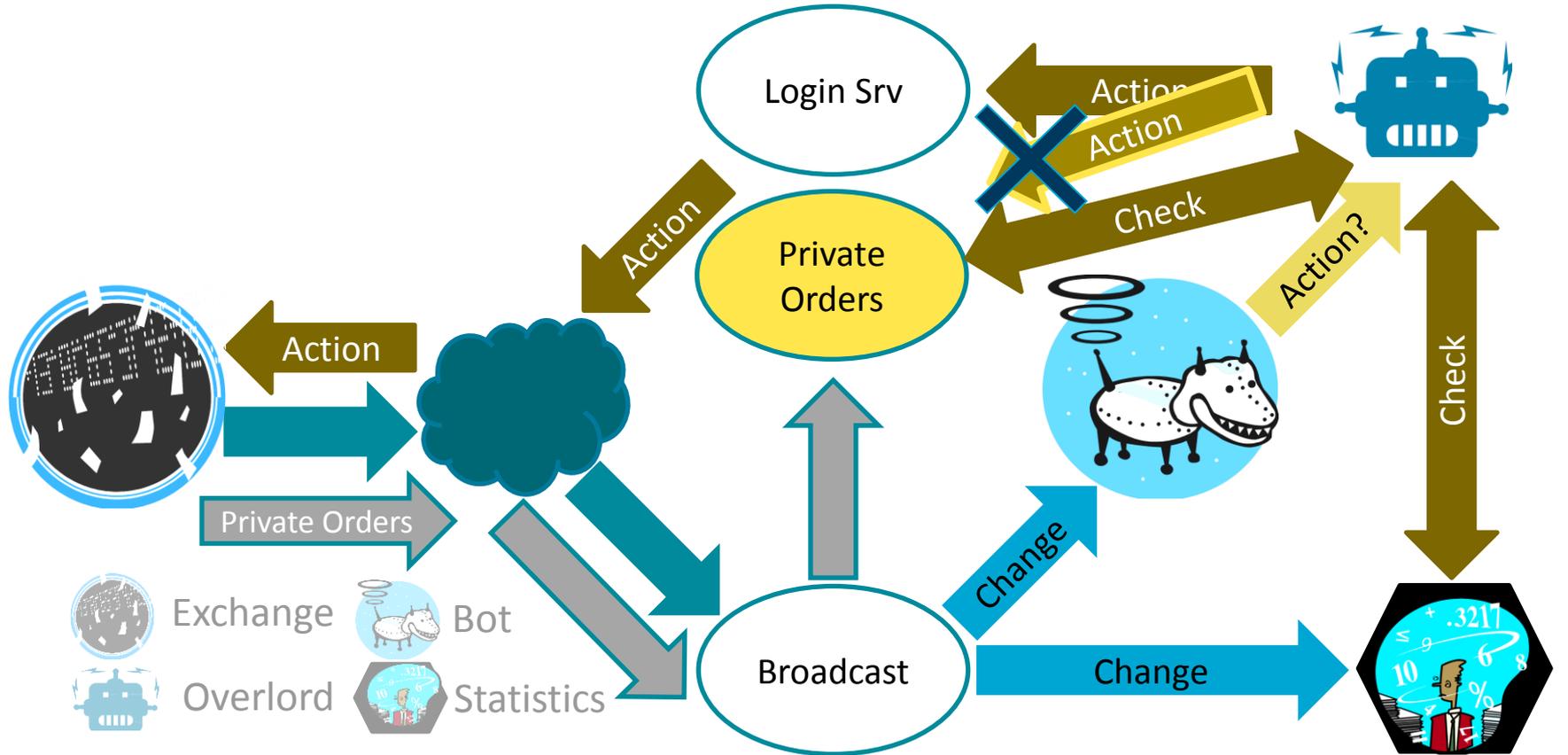
Waiting for a message



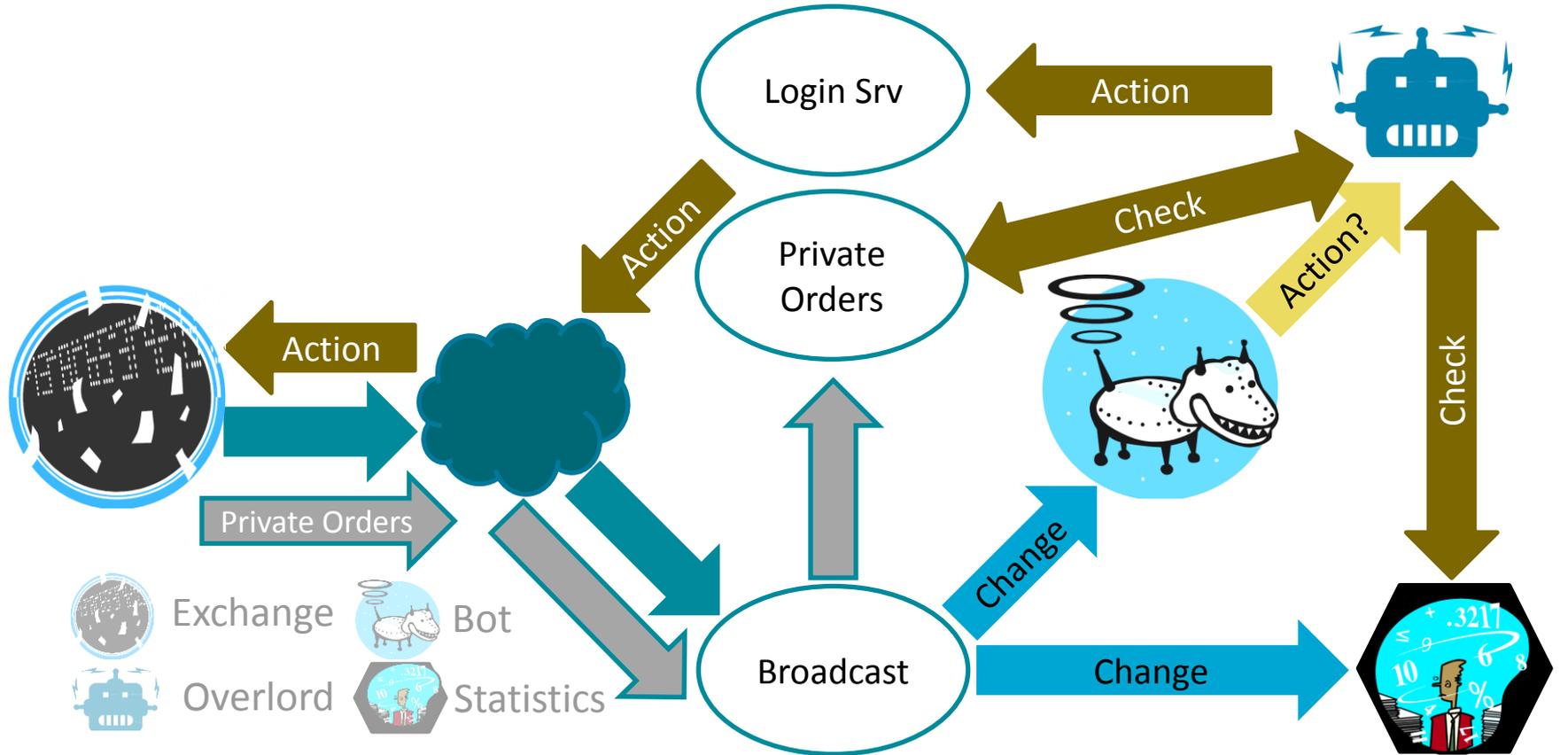
9.2.6 Dealing with the Real World. Waiting for a message



9.2.7 Dealing with the Real World. Cancel the change



9.2.8 Dealing with the Real World. DONE!



10. Lessons learned

- ▶ Erlang is cool 😊
- ▶ Log everything
- ▶ Automated mode \neq very fast manual mode
- ▶ Be aware of dependencies: next change could crash your system
- ▶ Test it
- ▶ Test it
- ▶ Test mode \neq Live mode
- ▶ Keep it simple, do not plan for the future
- ▶ Keep it simple and plan for the future
- ▶ Measure performance

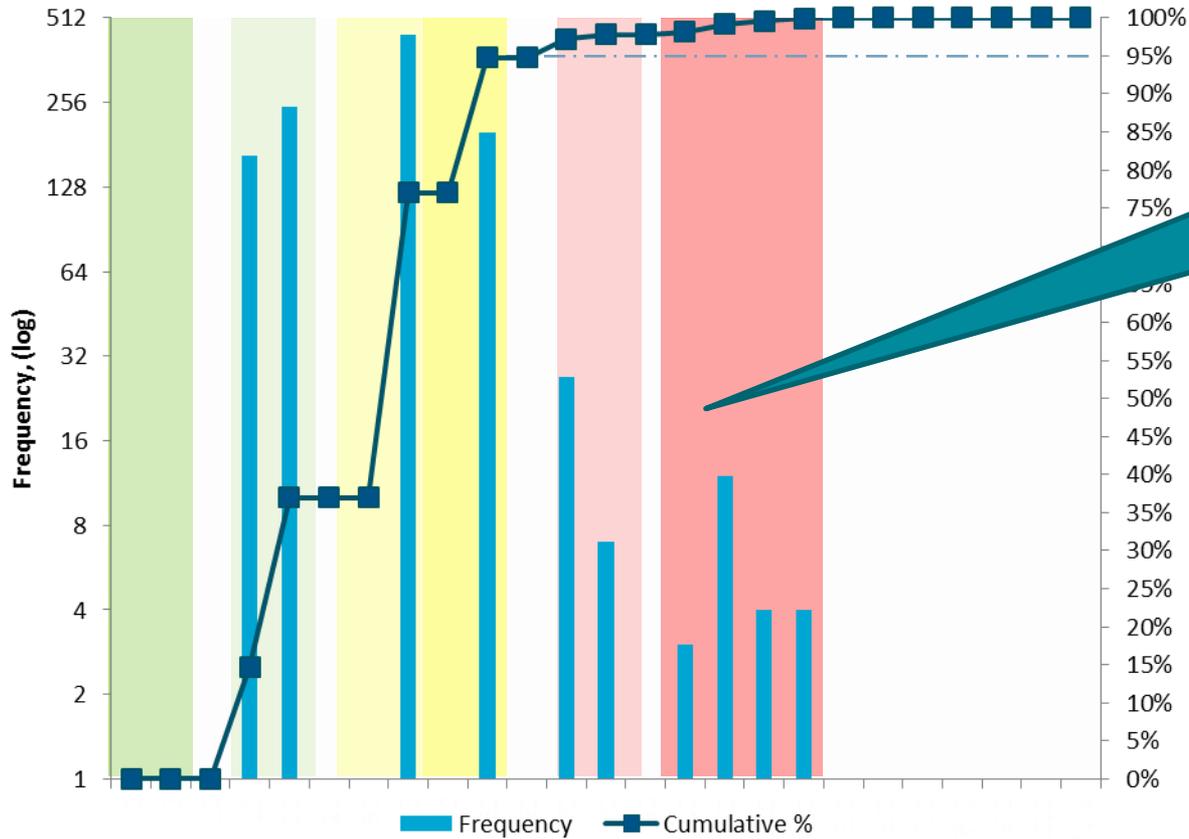
11. Open issues: Performance measurement

- ▶ folsom
- ▶ estatsd
- ▶ exometer

VS

- ▶ `timer:tc() + logger + grep`

11. Open issues: Performance deviation



Questions?