

Measuring Time

An earned value simulation study

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An EVM introduction



The EV terminology



A case study



The research project



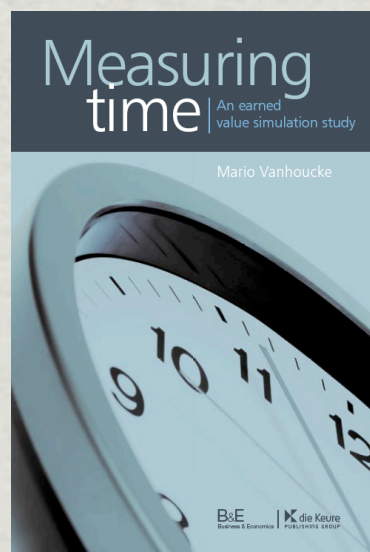
Static drivers of forecast accuracy

Dynamic drivers of forecast accuracy

Time sensitivity and corrective actions

Top-down or bottom-up project tracking

The software



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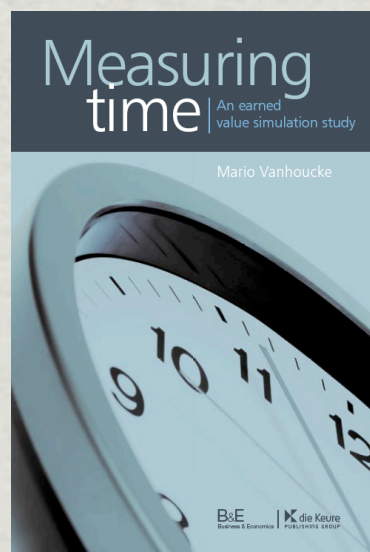
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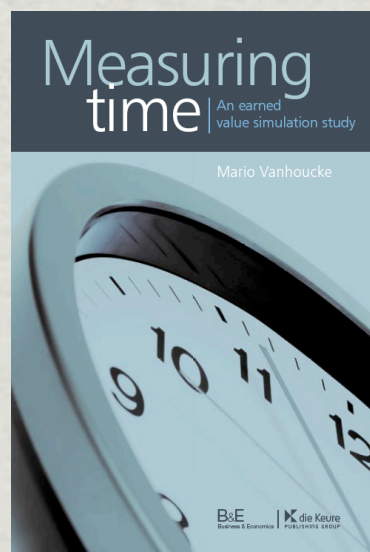
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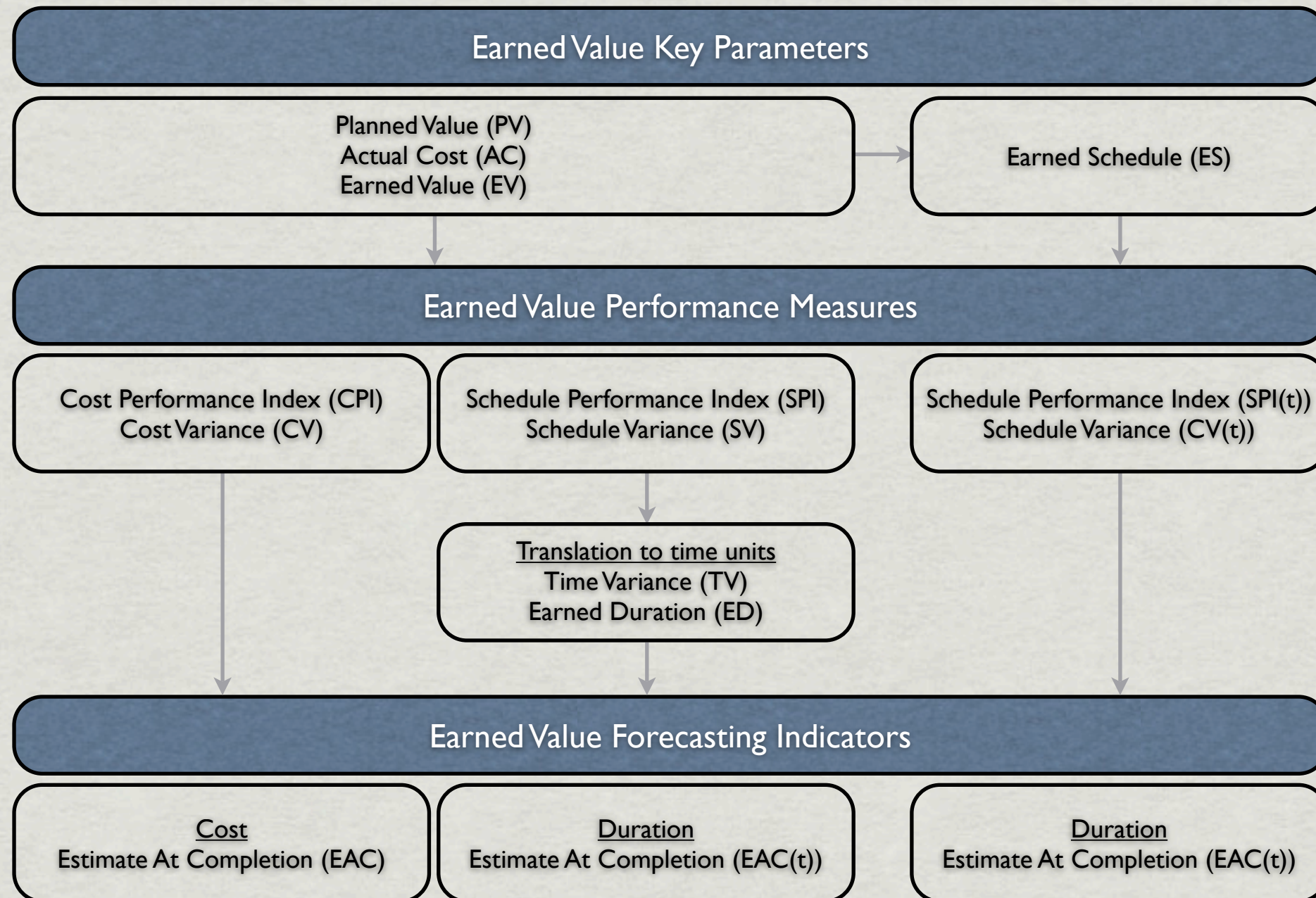
Time sensitivity and corrective actions

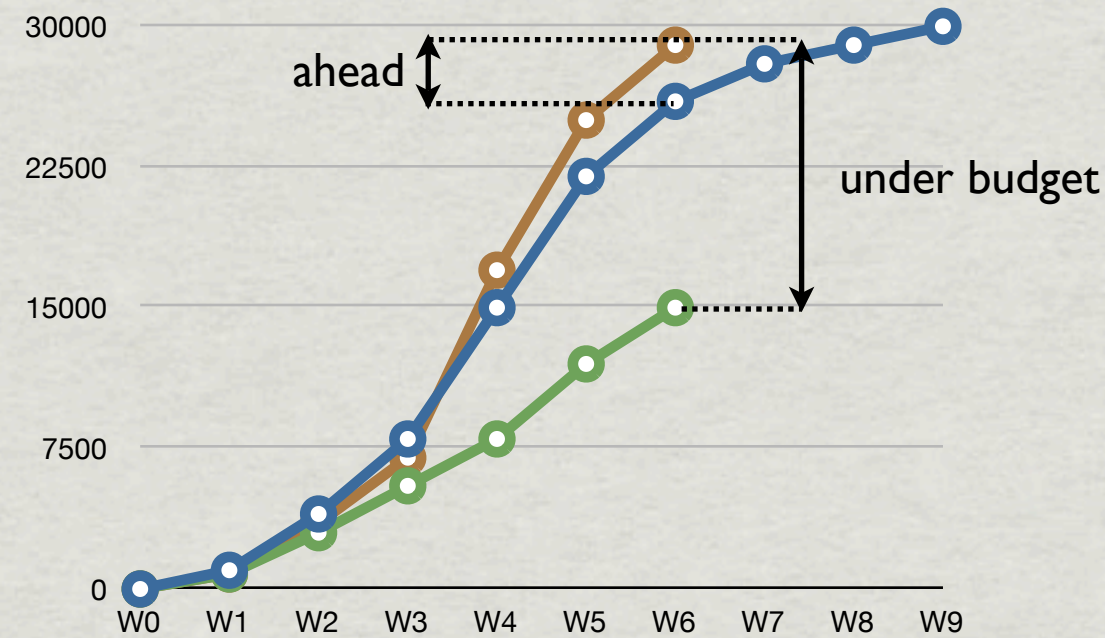
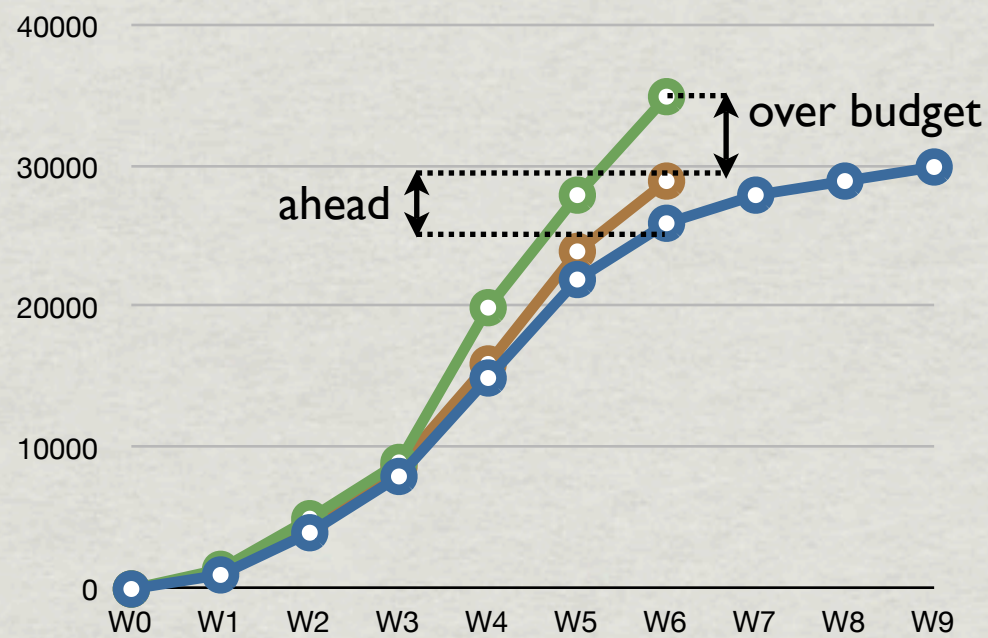
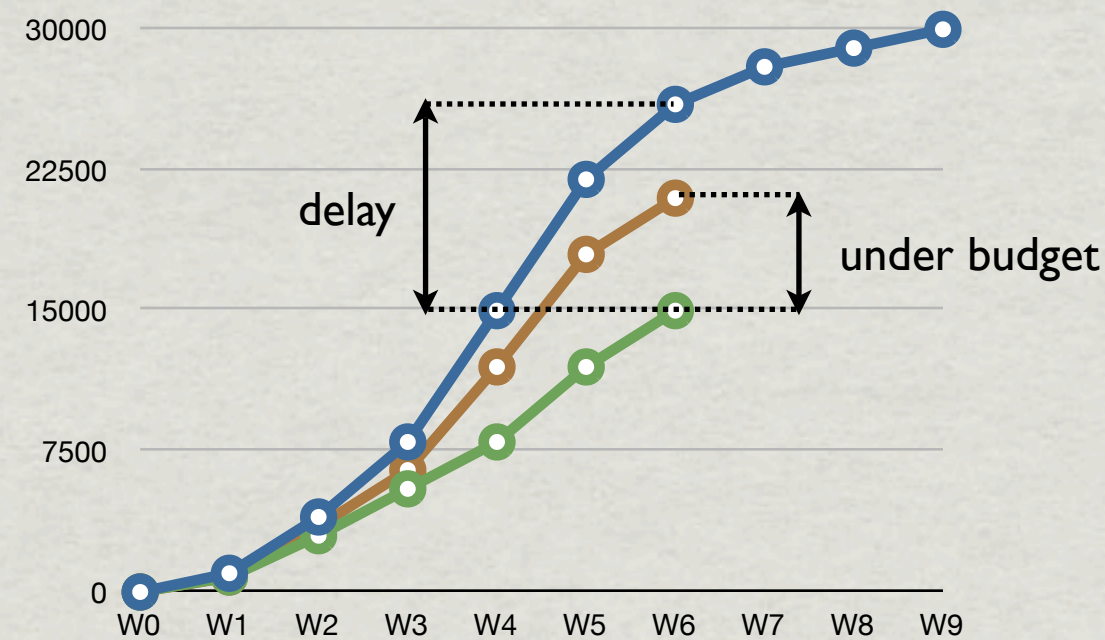
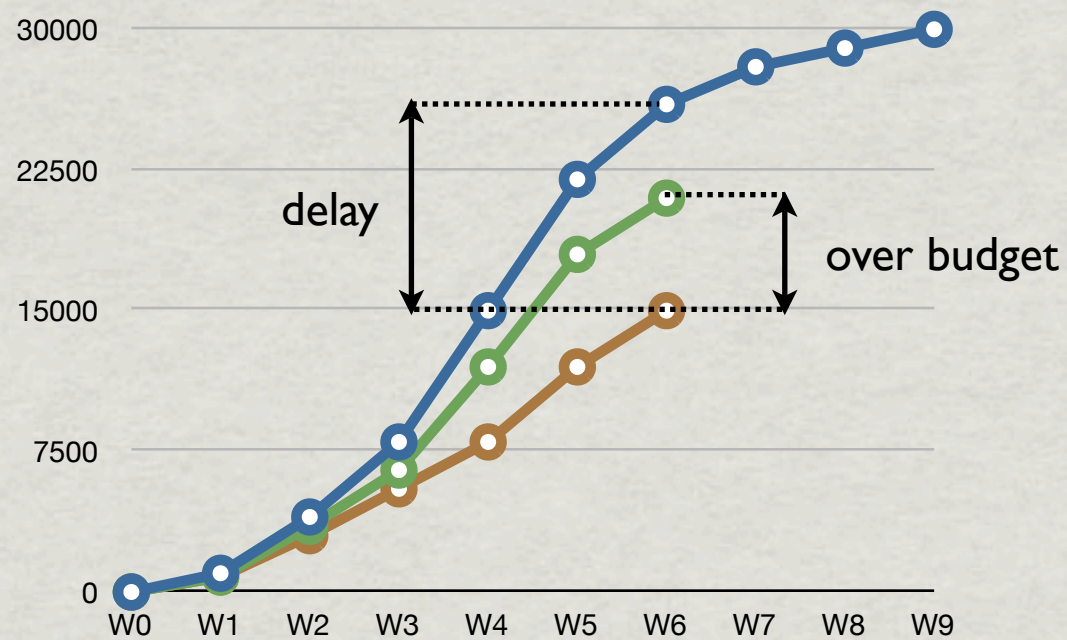
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EVM metrics

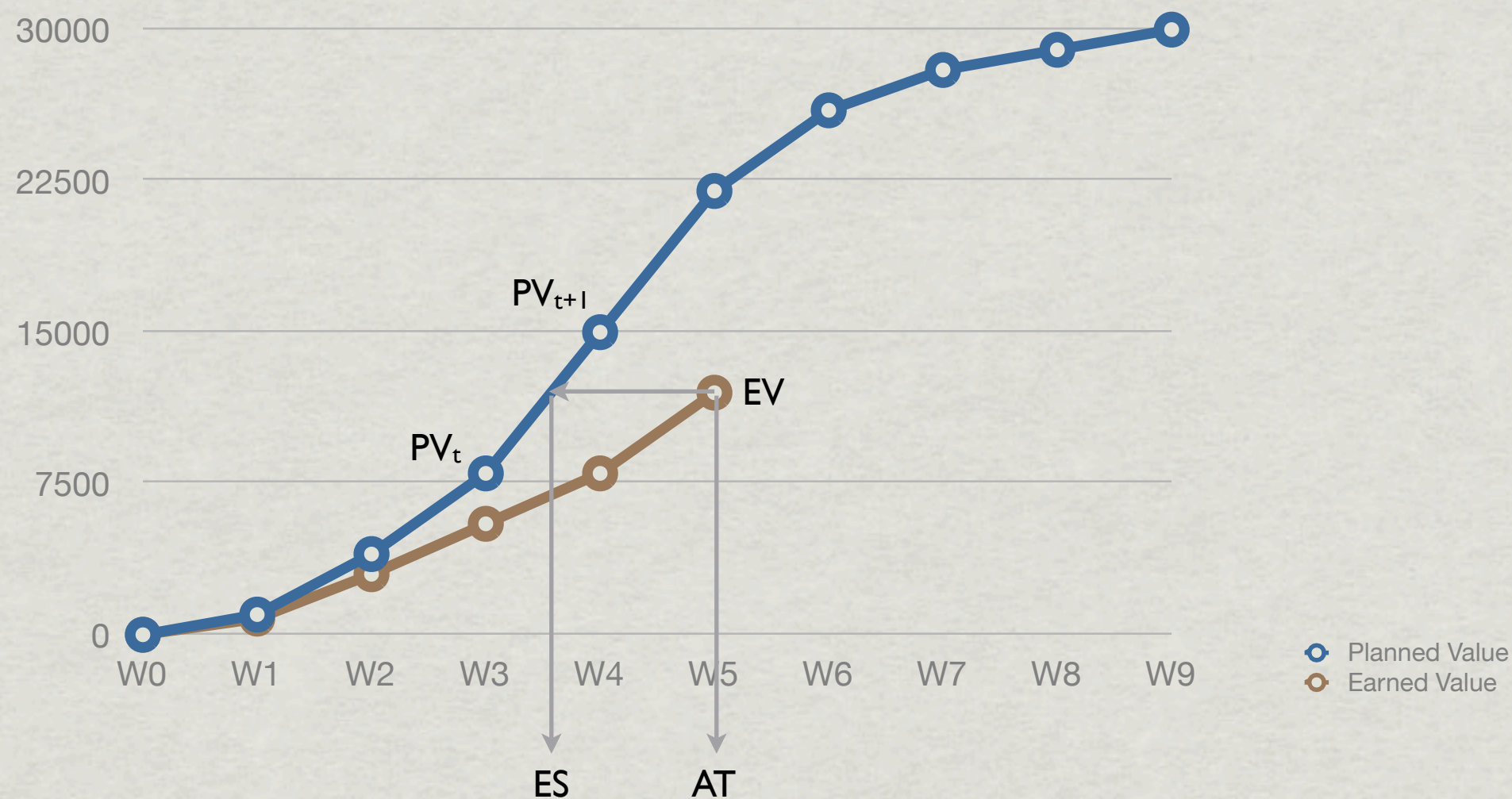




● PV
 ● AC
 ● EV

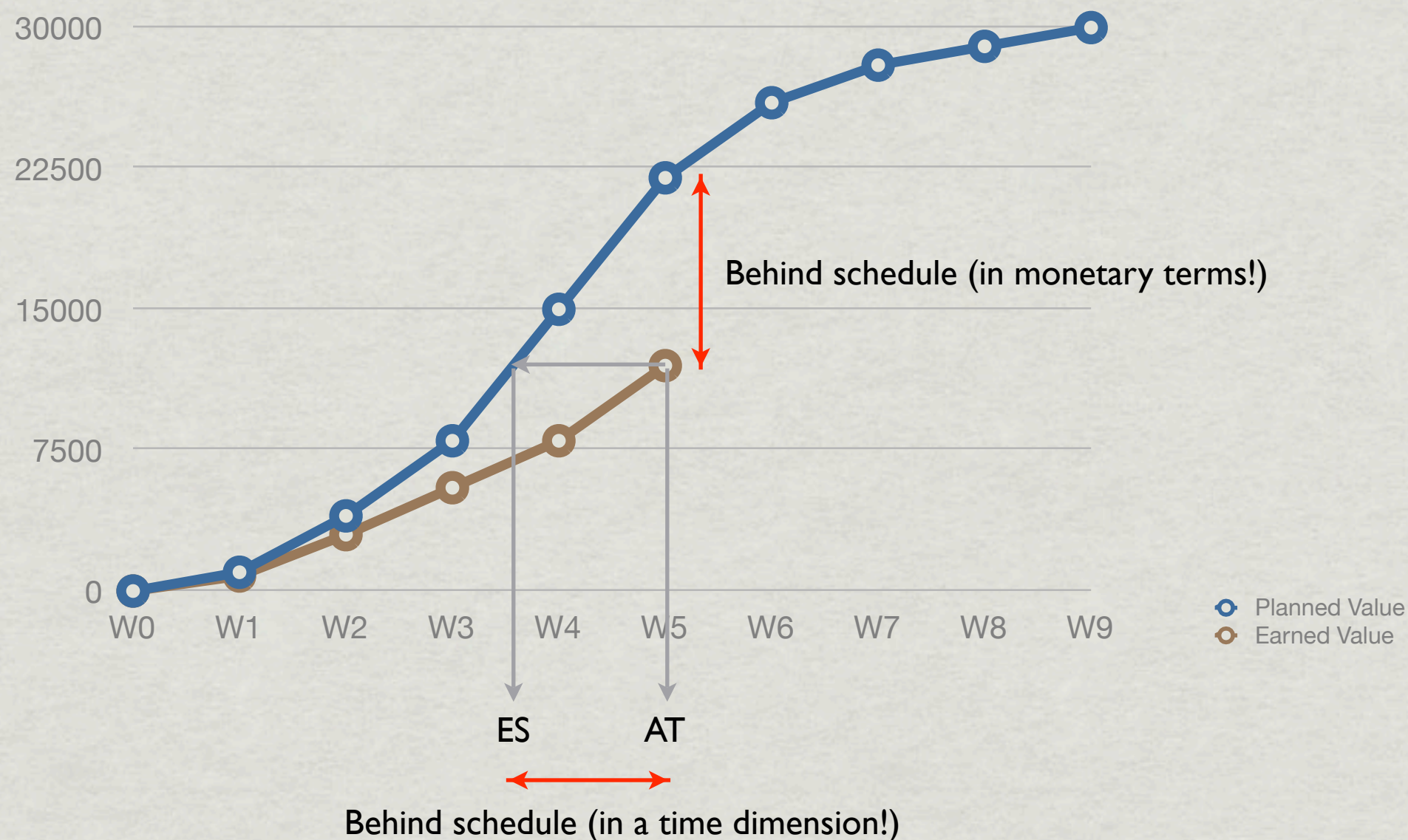
Earned Schedule ES (new!)

- * Find t such that $EV > PV_t$ and $EV < PV_{t+1}$
- * $ES = t + (EV - PV_t) / (PV_{t+1} - PV_t)$



Earned Schedule ES

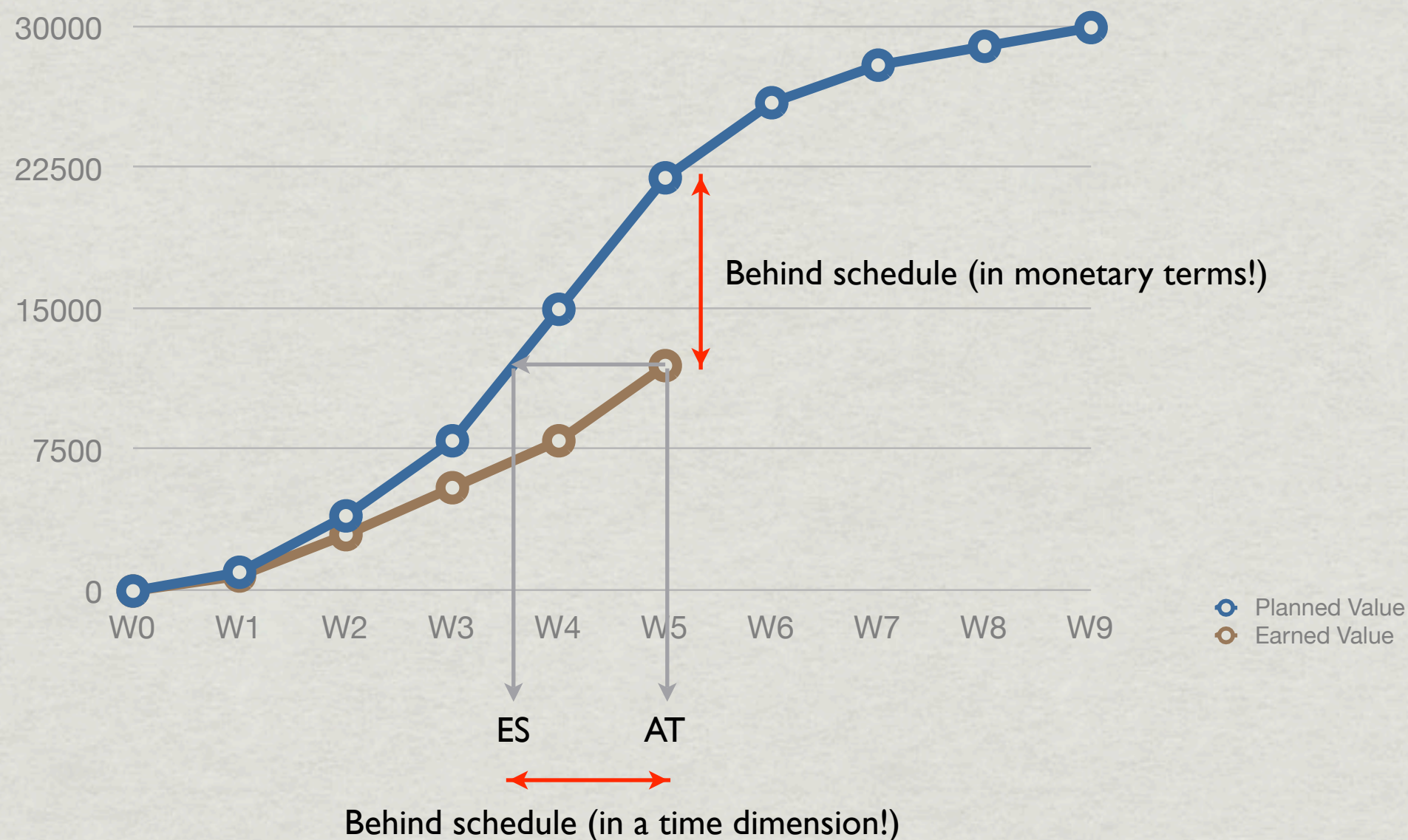
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Earned Schedule ES

ES measures time in
hours, days, weeks
or months!

- * Find t such that $EV > PV_t$ and $EV < PV_{t+1}$
- * $ES = t + (EV - PV_t) / (PV_{t+1} - PV_t)$



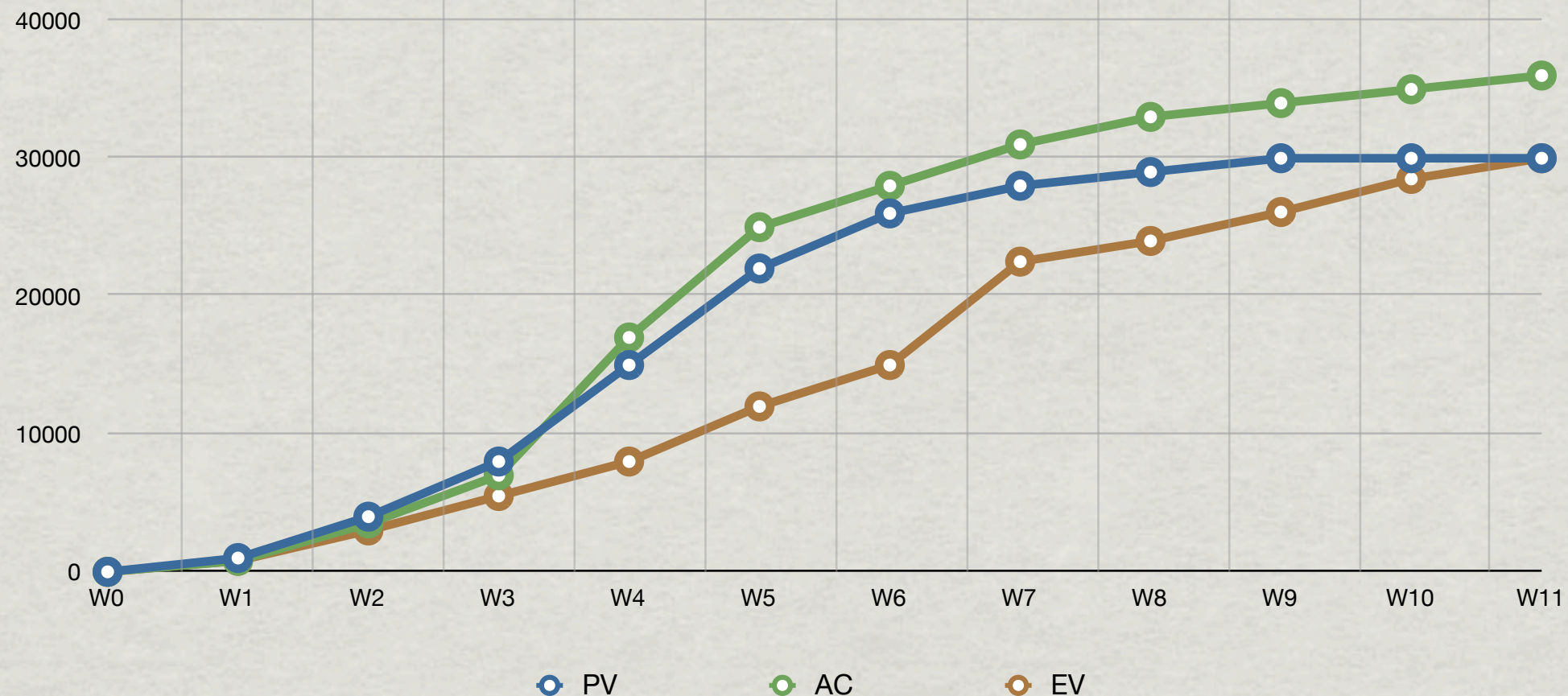
Performance

Planned Duration



Late!

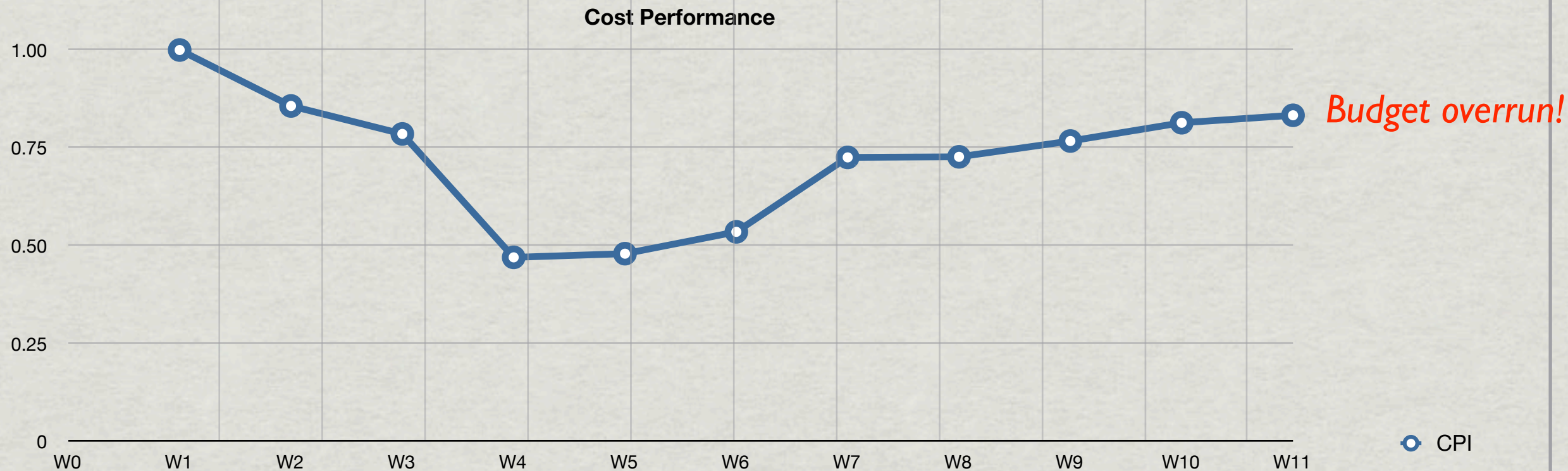
	W0	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11
PC	0.00%	2.67%	10.00%	18.33%	26.67%	40.00%	50.00%	75.00%	80.00%	87.00%	95.00%	100.00%
PV	0	1000	4000	8000	15000	22000	26000	28000	29000	30000	30000	30000
AC	0	800	3500	7000	17000	25000	28000	31000	33000	34000	35000	36000
EV	0	800	3000	5500	8000	12000	15000	22500	24000	26100	28500	30000
ES	0.00	0.80	1.67	2.38	3.00	2.29	4.00	5.08	5.29	6.03	7.25	9.00
SPI		0.80	0.75	0.69	0.53	0.55	0.58	0.80	0.83	0.87	0.95	1.00
SPI(t)		0.80	0.83	0.79	0.75	0.46	0.67	0.73	0.66	0.67	0.73	0.82
CPI		1.00	0.86	0.79	0.47	0.48	0.54	0.73	0.73	0.77	0.81	0.83



Performance

✱ Cost performance: cost overrun! → Correct measure

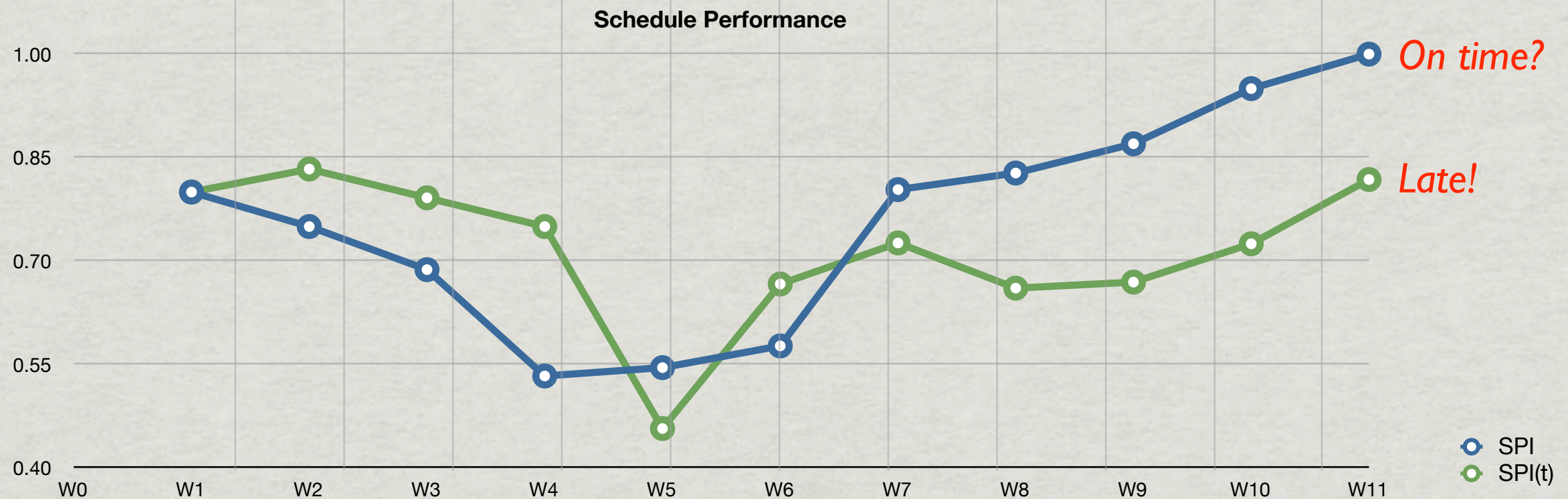
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Performance

* Time performance: → quirky behavior!

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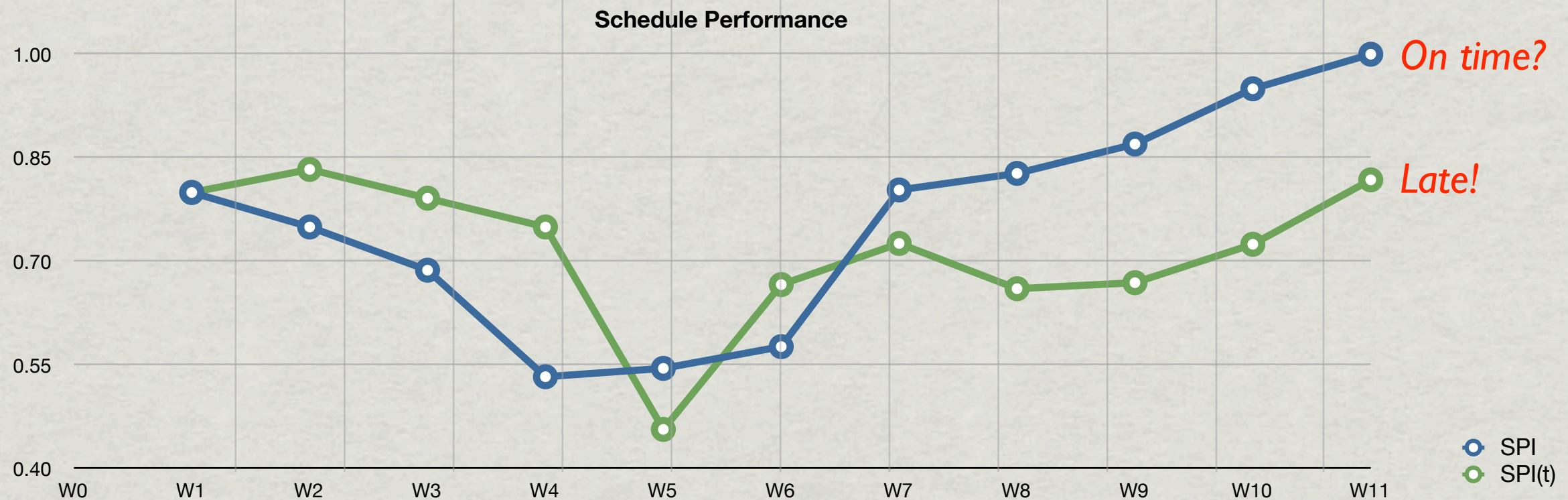


Performance

ES measures real time performance until the end of the project!

* Time performance: → quirky behavior!

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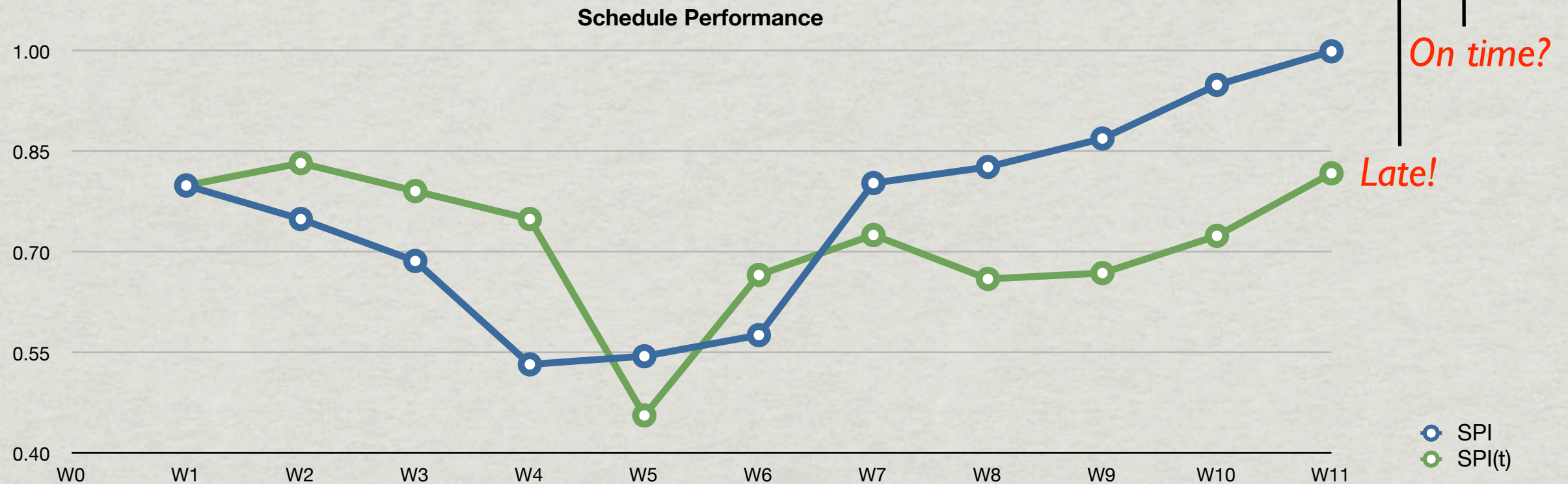
$SPI = EV / PV \Rightarrow \text{End of project: } EV = PV \Rightarrow SPI = 1 \text{ (always!)}$

$SPI(t) = ES / AD \Rightarrow \text{End of project: } ES = PD$

$ES > AD \text{ (early)} \Rightarrow SPI(t) > 1$

$ES = AD \text{ (on time)} \Rightarrow SPI(t) = 1$

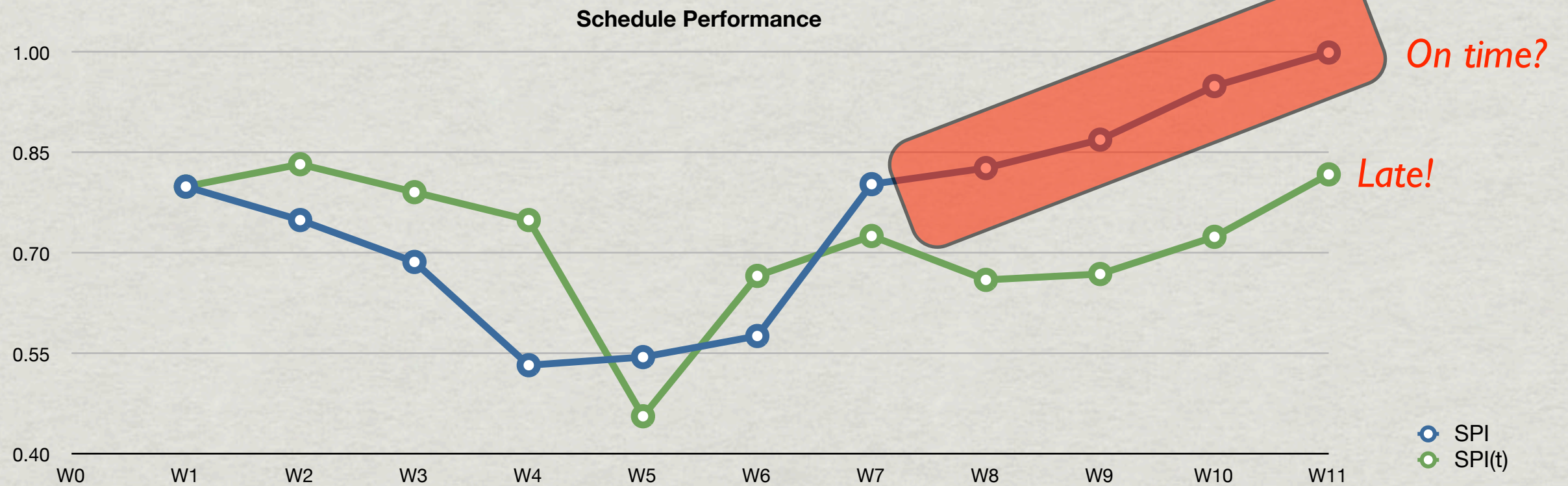
$ES < AD \text{ (late)} \Rightarrow SPI(t) < 1$



Unreliable region for performance measurement!



Inaccurate time forecast!



Forecasting

- ✱ General idea: based on current performance

Forecasting methods

Traditional methods
(PV, AC and EV)

Novel method
(ES)

Current Project Performance

		Planned Value Method	Earned Duration Method	Earned Schedule Method
PF = 1	Future follows the schedule	$EAC(t)_{PV1}$	$EAC(t)_{ED1}$	$EAC(t)_{ES1}$
PF = SPI or SPI(t)	Future time performance = Current time performance	$EAC(t)_{PV2}$	$EAC(t)_{ED2}$	$EAC(t)_{ES2}$
PF = SCI or SCI(t)	Future time performance = Current time/cost performance	$EAC(t)_{PV3}$	$EAC(t)_{ED3}$	$EAC(t)_{ES3}$

Forecasting

ES predicts the future
in a better way?

- ✱ General idea: based on current performance

Forecasting methods

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(PV, AC and EV)

Novel method
(ES)

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Forecasting

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- * General idea: based on current performance

Forecasting methods

Current Project Performance

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The EV terminology



A case study



The research project



Static drivers of forecast accuracy

Dynamic drivers of forecast accuracy

Time sensitivity and corrective actions

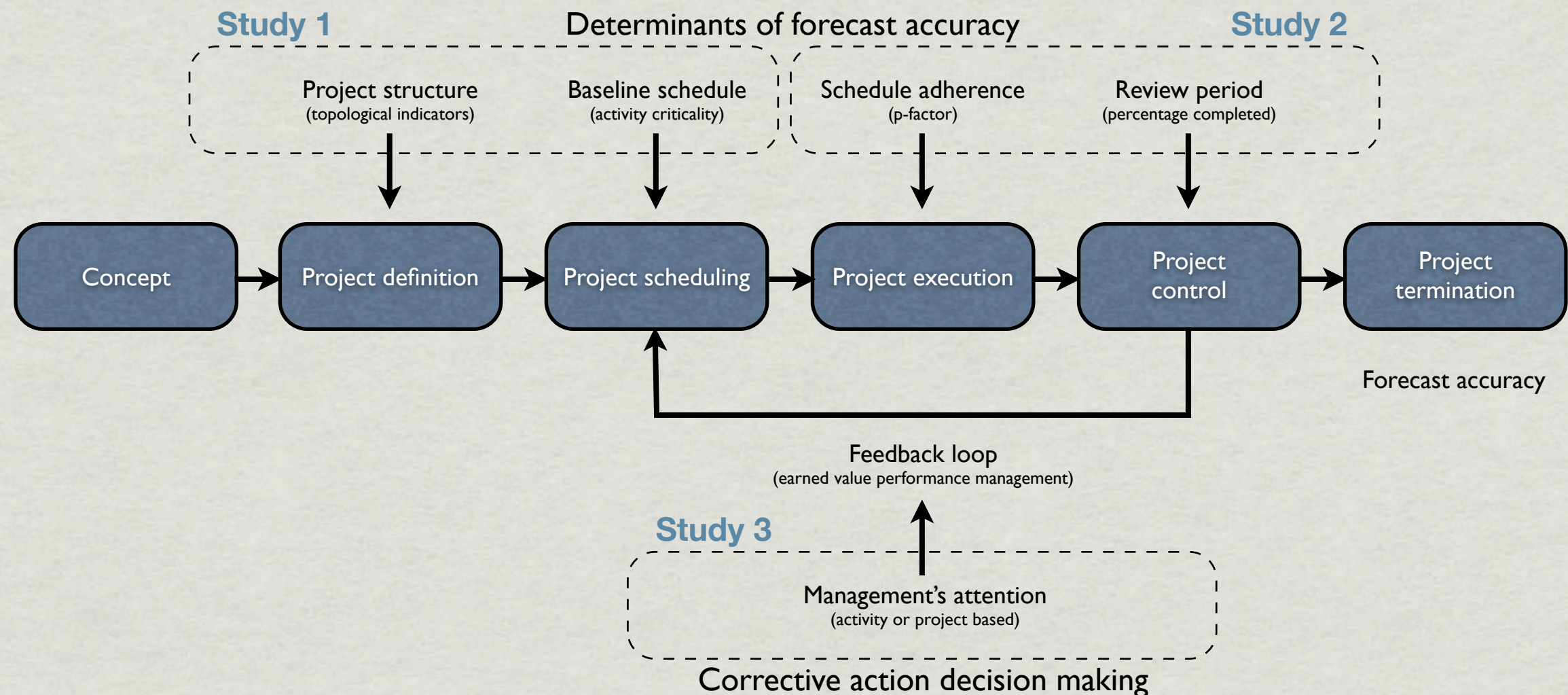
Top-down or bottom-up project tracking

The software



Research project

- * General conclusions instead of often subjective case study statements!
- * Research topic 1: Static forecast accuracy drivers
- * Research topic 2: Dynamic forecast accuracy drivers
- * Research topic 3: Guide the corrective action decision making process



An EVM introduction



The EV terminology



A case study



The research project



Static drivers of forecast accuracy

Dynamic drivers of forecast accuracy

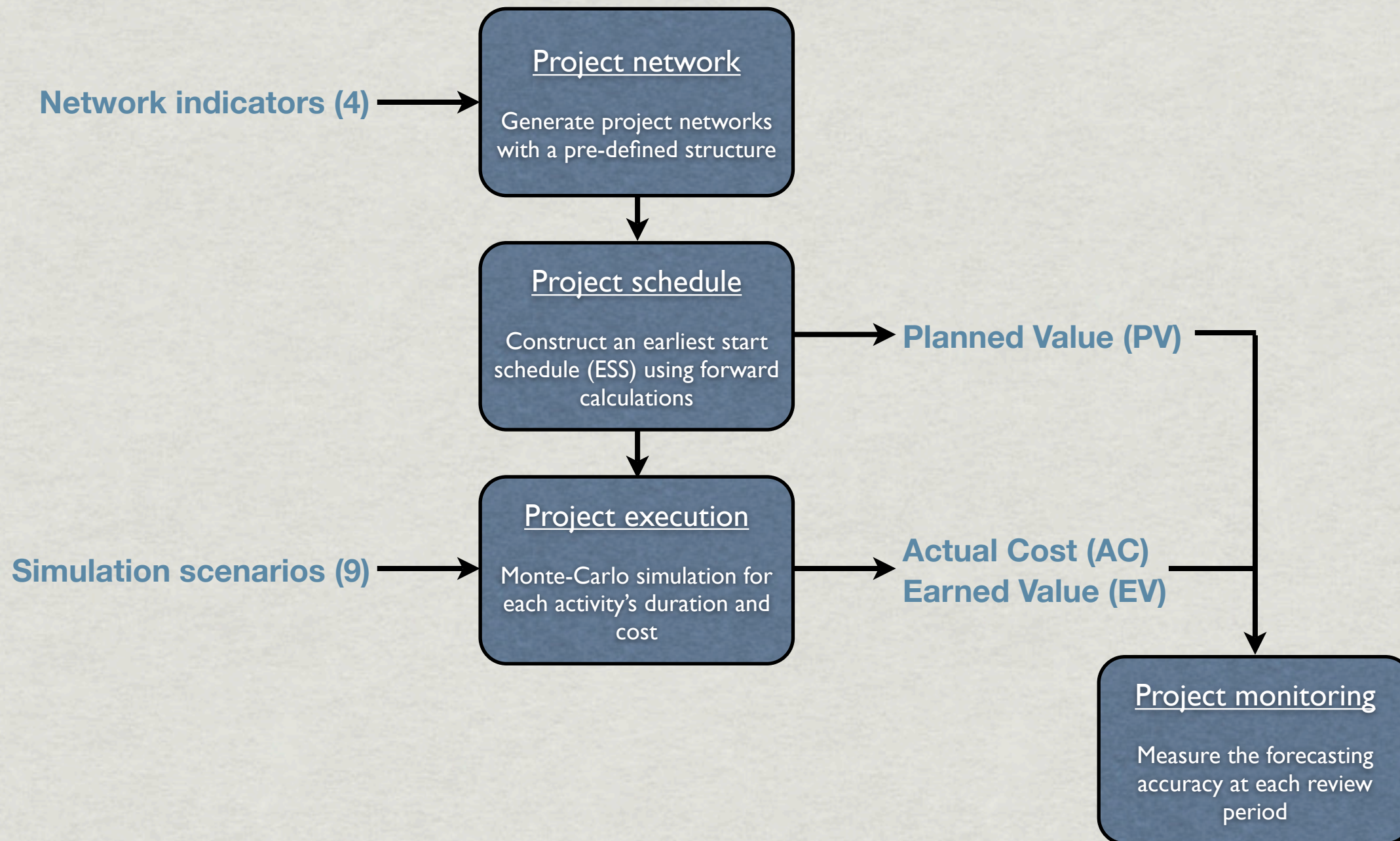
Time sensitivity and corrective actions

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Methodology



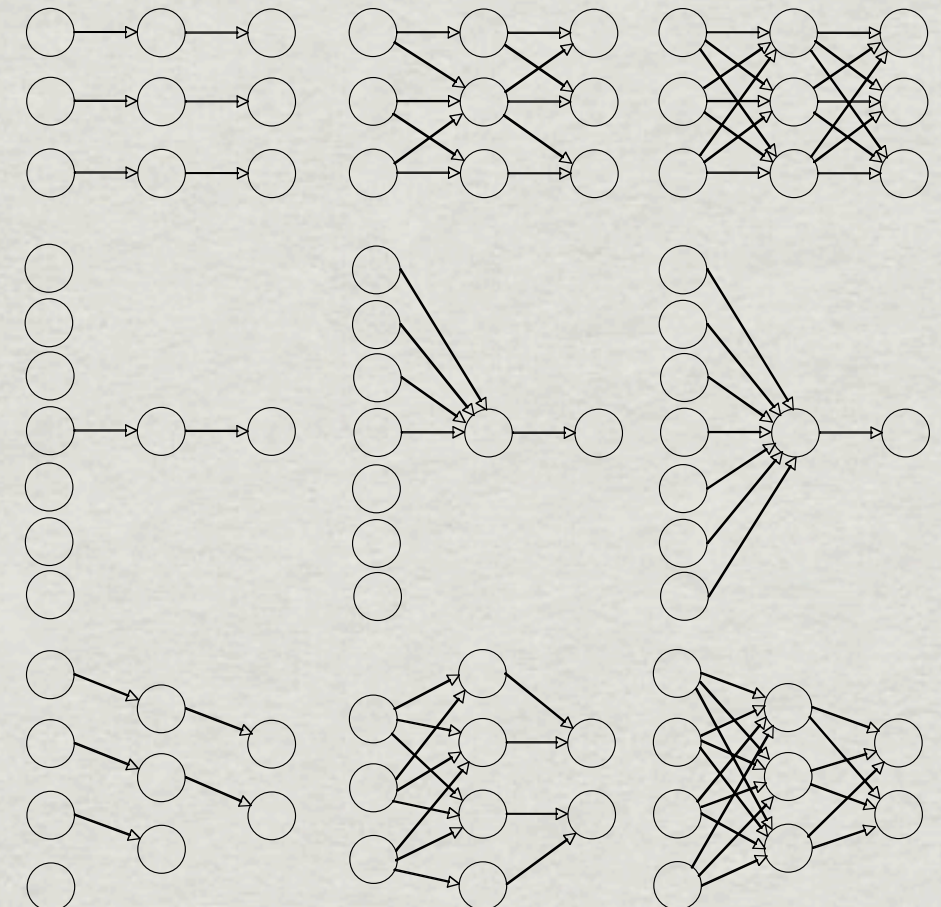
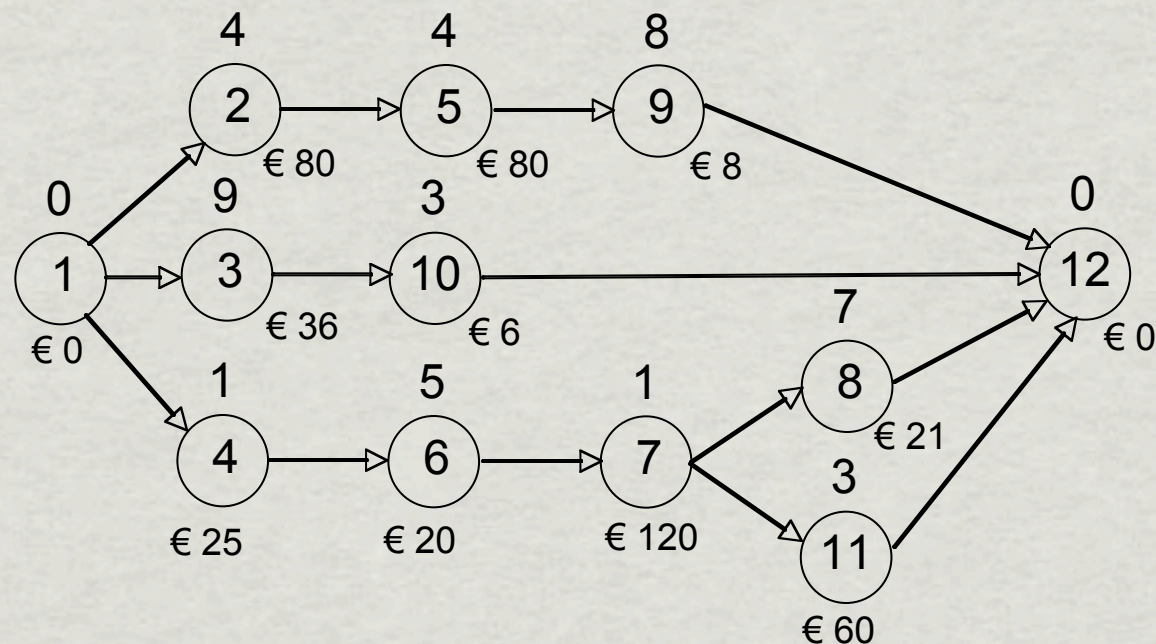
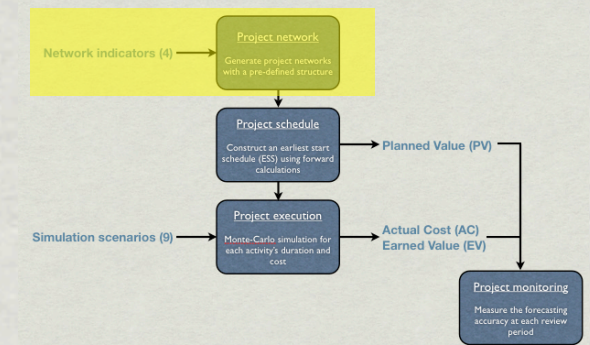
Project network

* Topological structure of a network

- * Number of activities, precedence relations,
- * Influence on risk of delay, computer speed, schedule quality, resource consumption, etc...

* Wide and diverse set of project networks

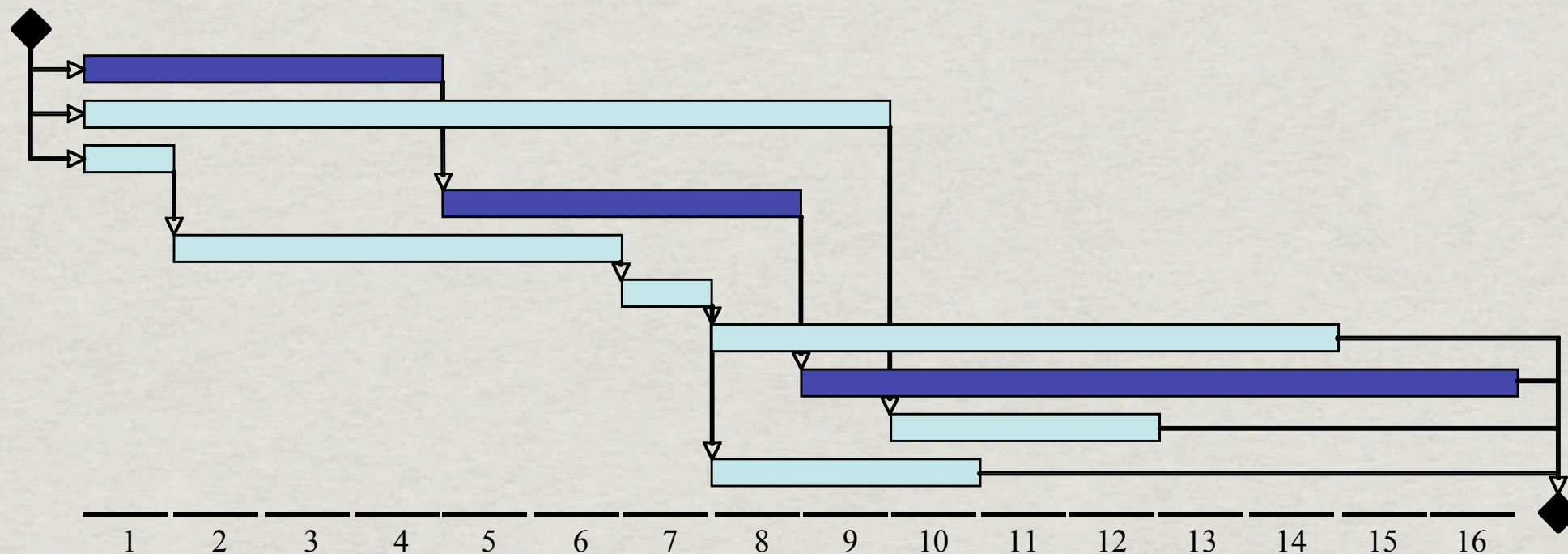
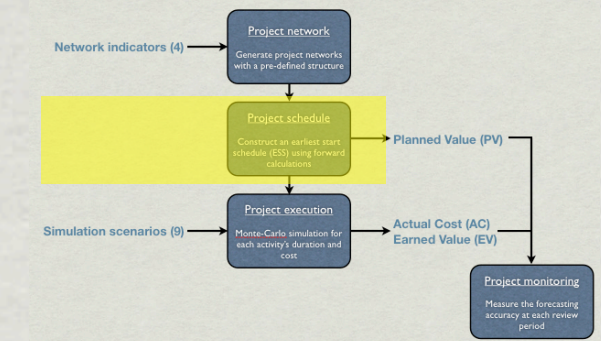
- * Idea: span the full range of complexity
- * Parameter: SP indicator to measure the degree between a serial/parallel network



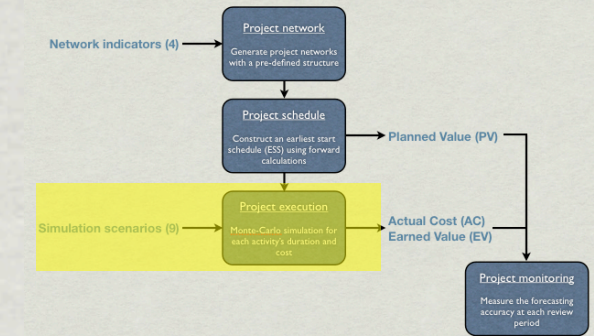
Baseline schedule

* Construction of baseline schedule

- * Critical path method: ESS → Planned Value PV → S-curve
- * Point-of-reference: The real purpose of a project schedule is to act as a ***predictive model*** of a team of resources and the project work destined for that team



Simulation scenarios



		Critical activities		
		-	0	+
Non-critical activities	-	1. SPI(t) > I RD < PD	4. SPI(t) > I RD = PD	7. SPI(t) > I RD > PD
	0	2. SPI(t) > I RD < PD	5. SPI(t) = I RD = PD	8. SPI(t) < I RD > PD
	+	3. SPI(t) < I RD < PD	6. SPI(t) < I RD = PD	9. SPI(t) < I RD > PD

Legend:

SPI(t): average project early warning performance signal

> I: average positive signal (ahead of schedule)

< I: average negative signal (schedule delay)

RD: Real project duration

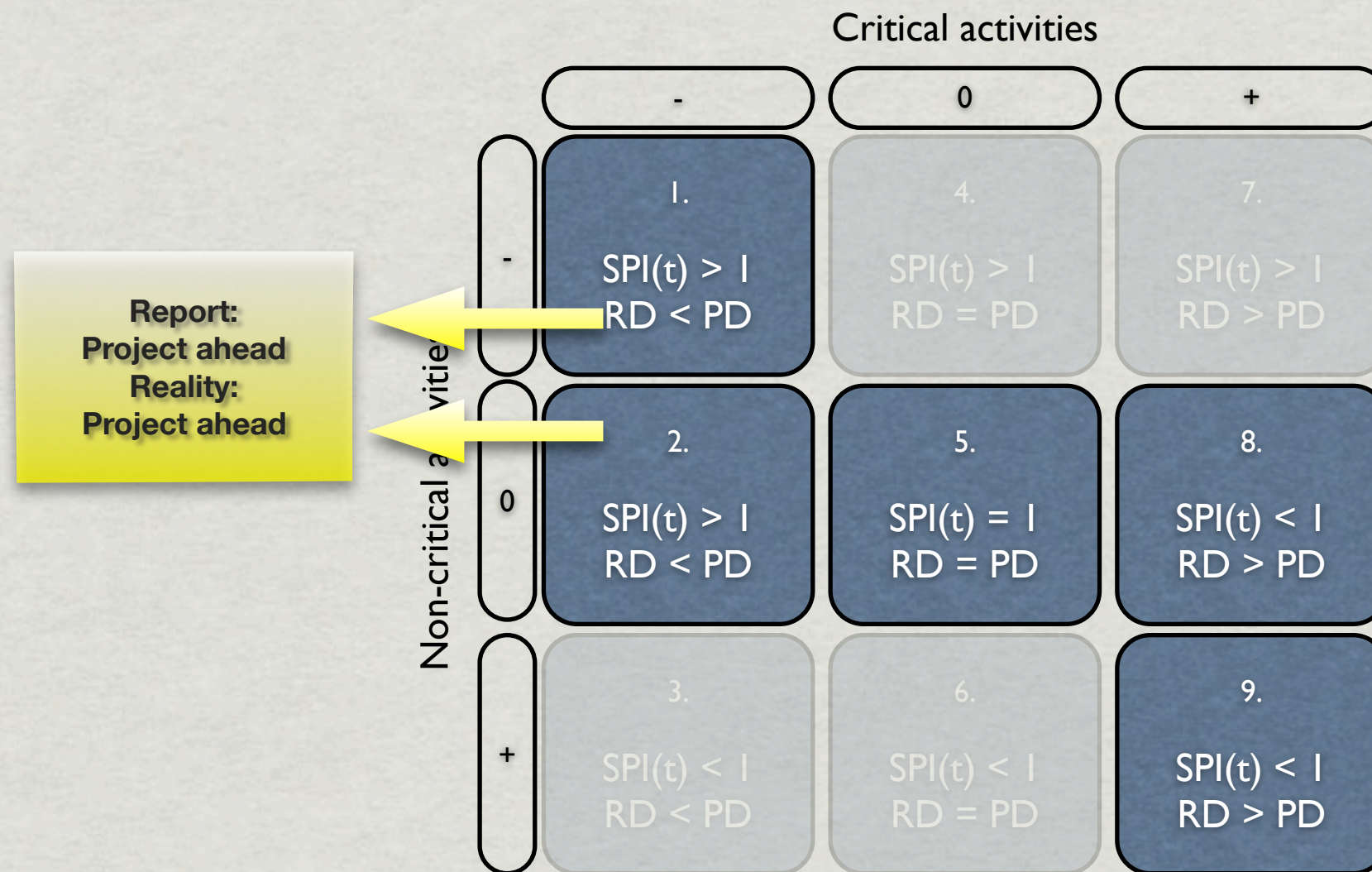
Simulation scenarios

* The true scenarios

		Critical activities		
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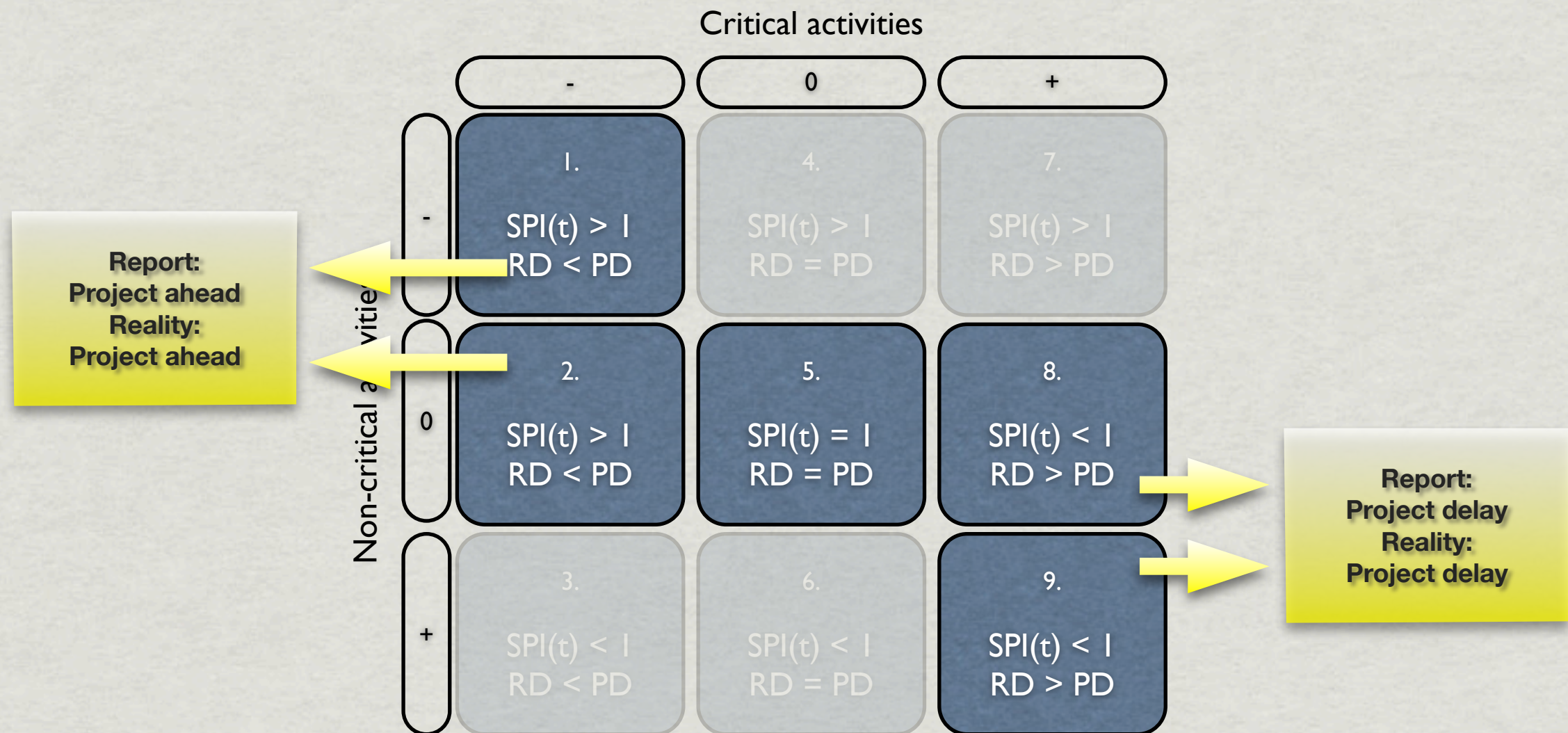
Simulation scenarios

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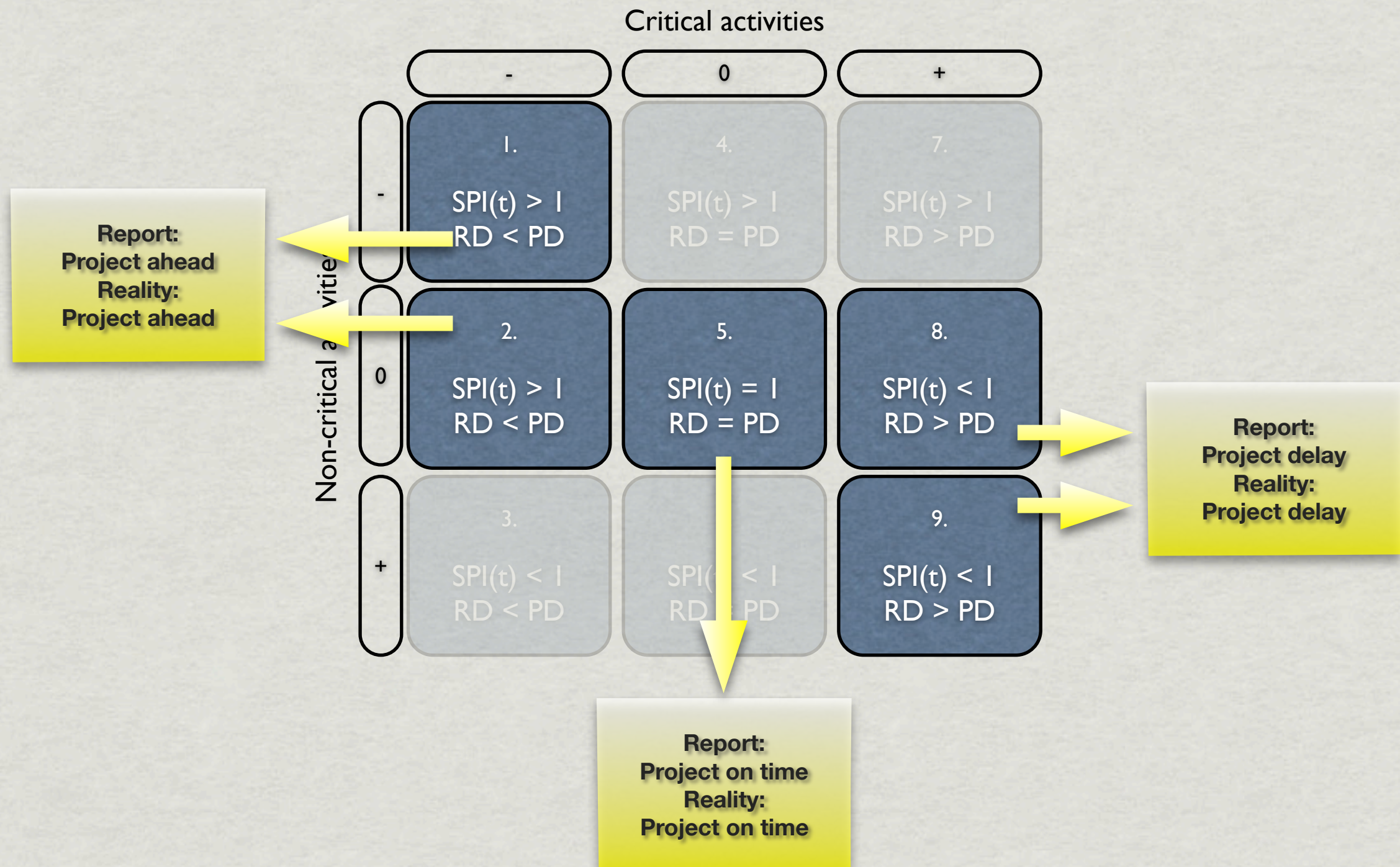
Simulation scenarios

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Simulation scenarios

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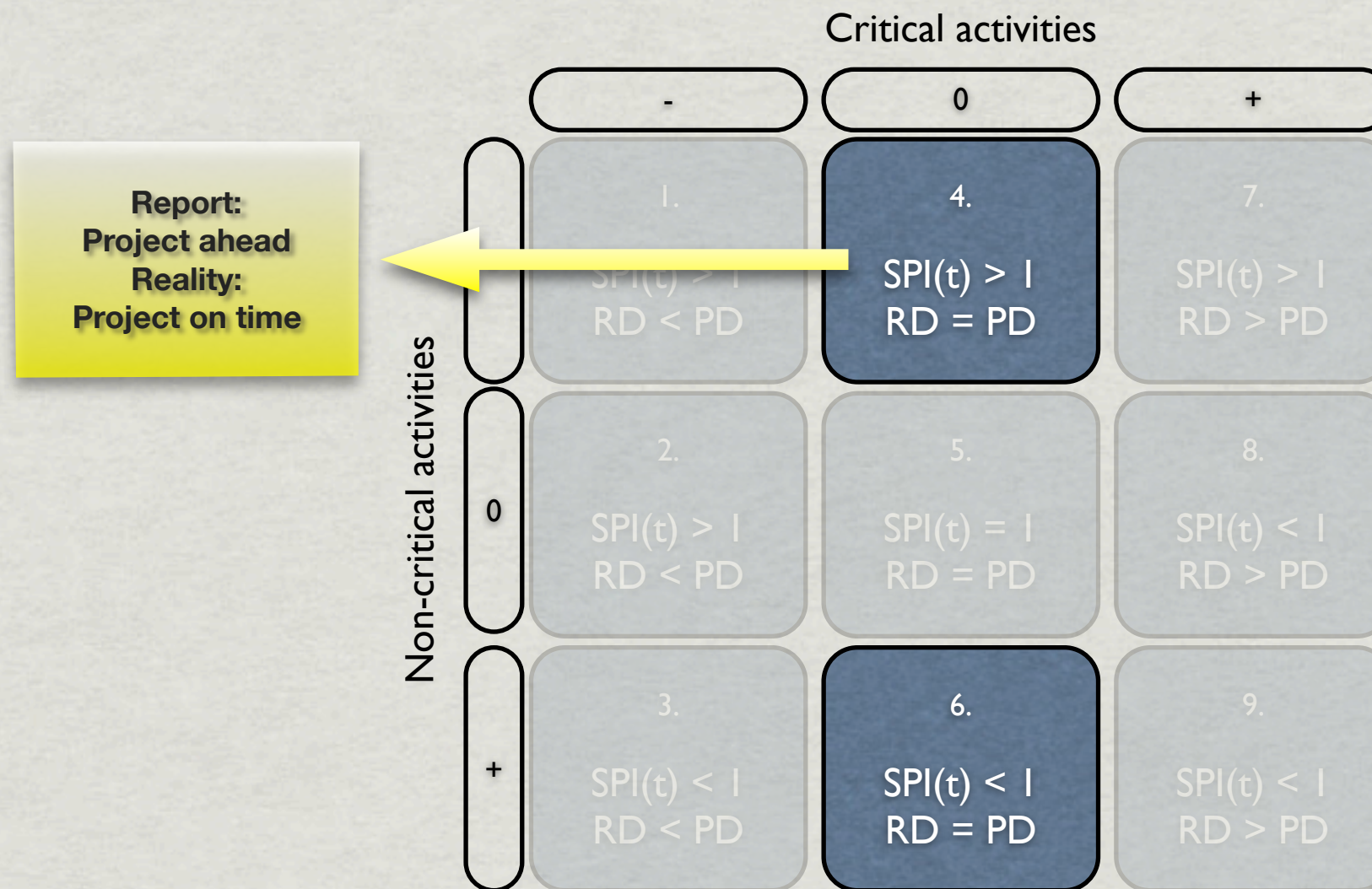
Simulation scenarios

* The misleading scenarios

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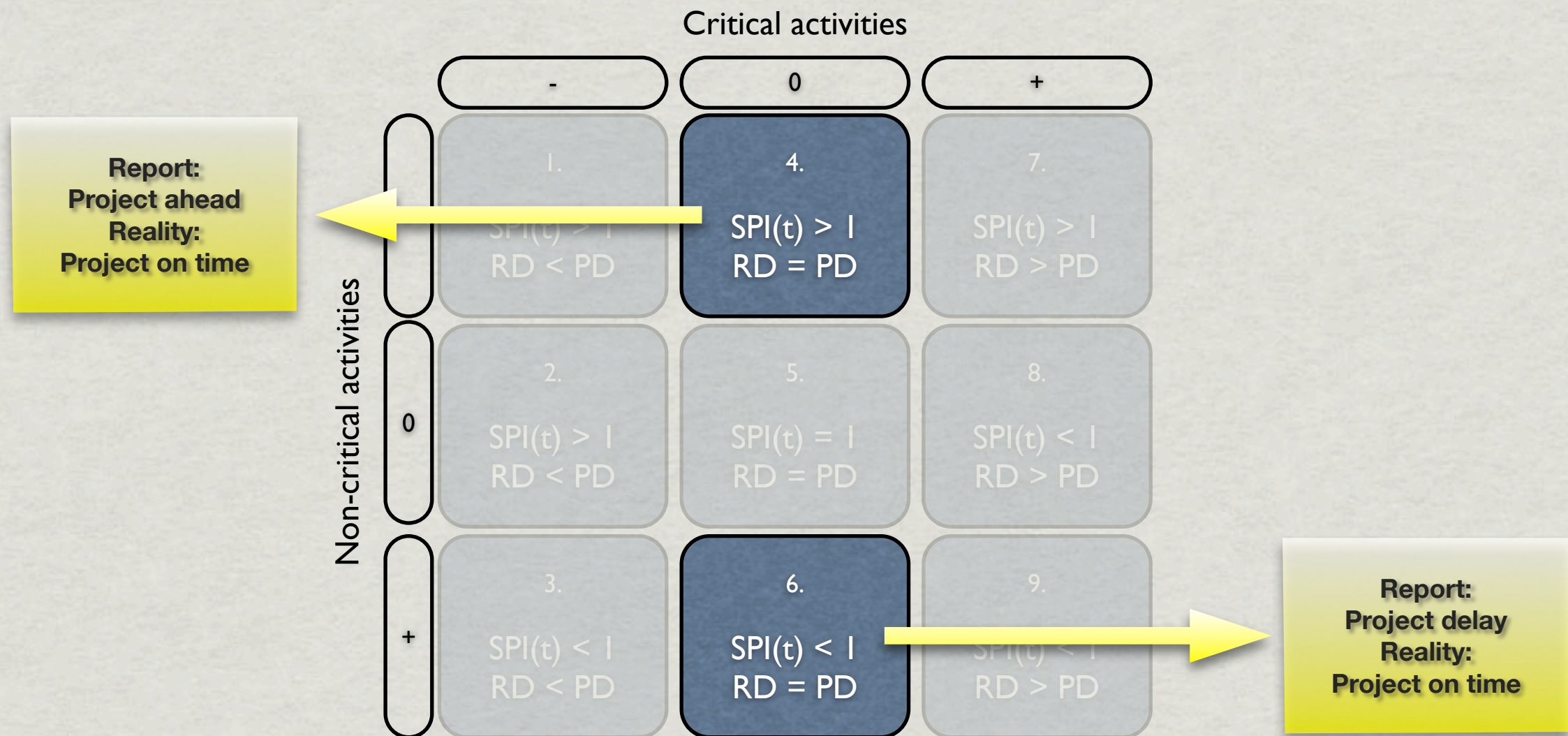
Simulation scenarios

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Simulation scenarios

* The misleading scenarios



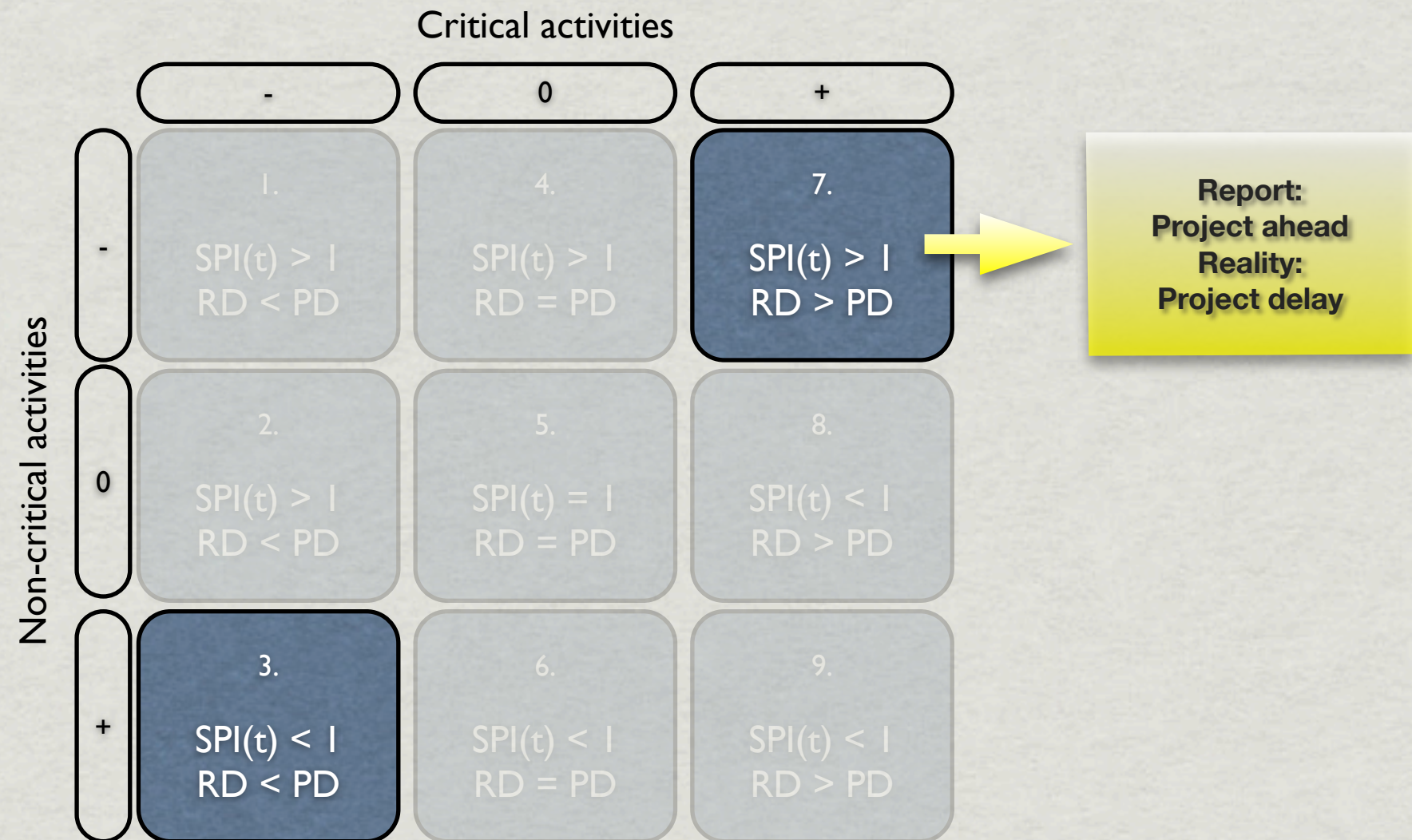
Simulation scenarios

* The false scenarios

		Critical activities		
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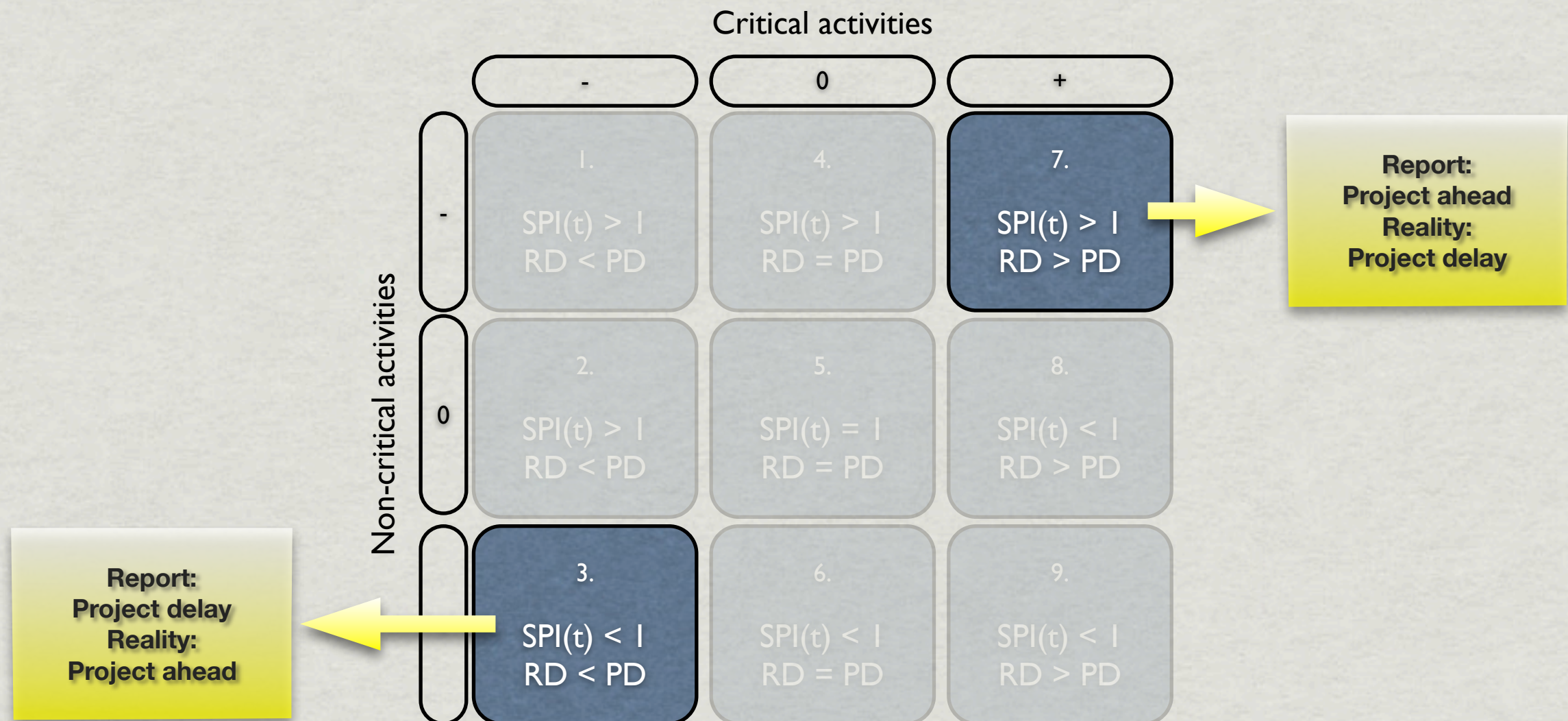
Simulation scenarios

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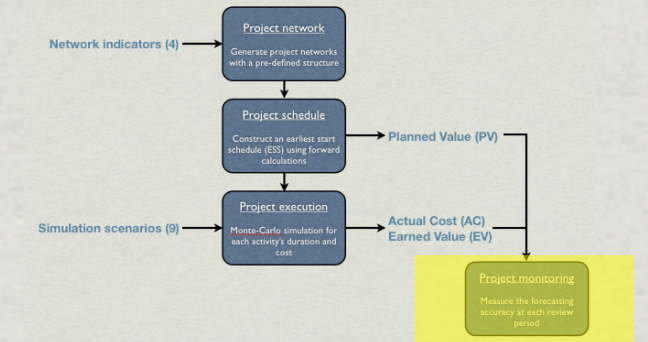


Simulation scenarios

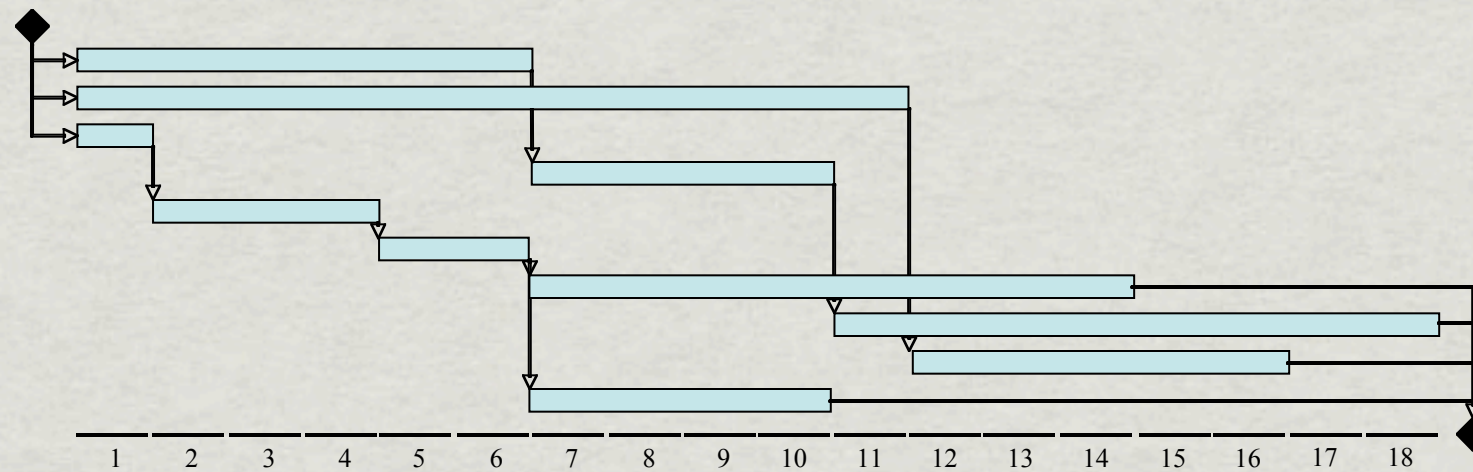
* The false scenarios



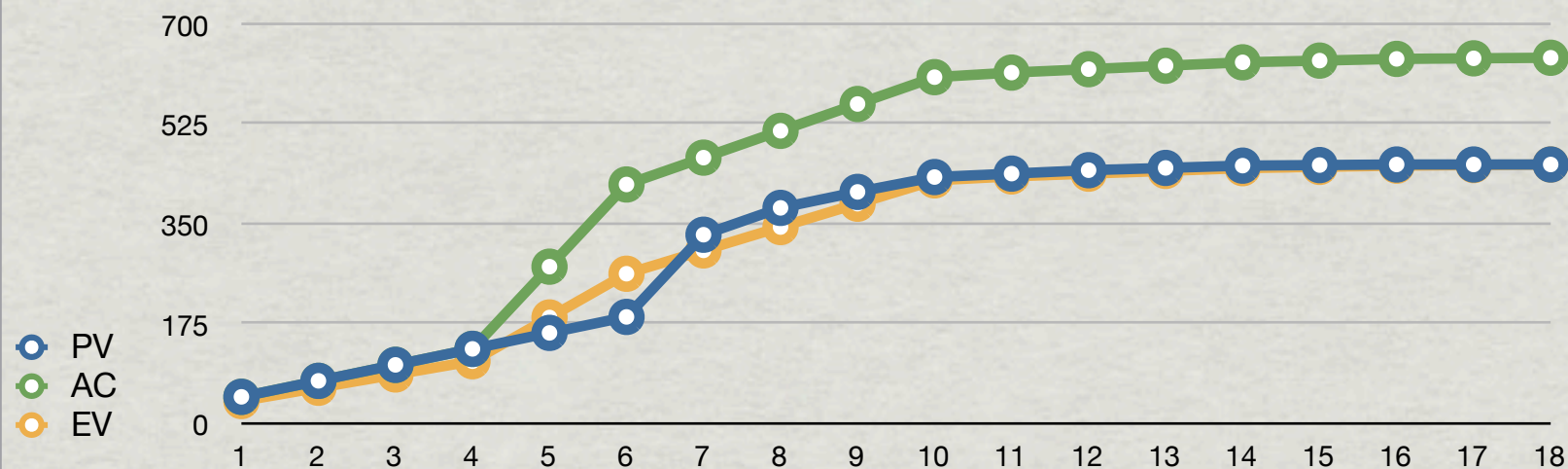
Forecast accuracy



✱ Project schedule and real-life execution: Murphy strikes!



➡ Real project duration



➡ SPI(t) per period

➡ EAC(t) per period ⇒ Average EAC(t) over complete horizon

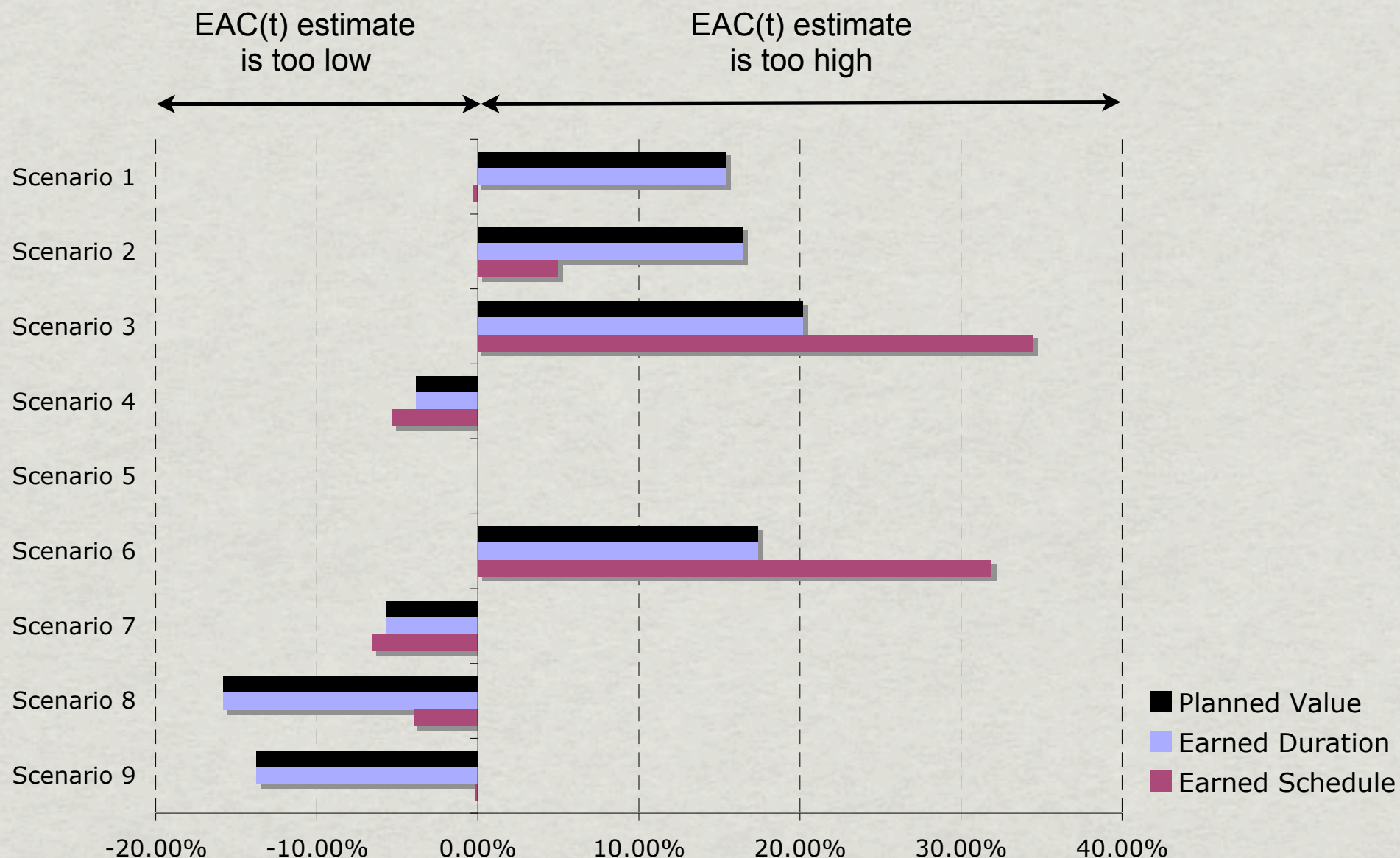
Forecast accuracy

= quality of average EAC(t) prediction

= difference between average EAC(t) and RD

Results (1)

The earned schedule method outperforms, on average, the more traditional method (planned value method and earned duration method)



True scenarios
(1, 2, 5, 8, 9)

ES >> PV and ED

Misleading scenarios
(4, 6)

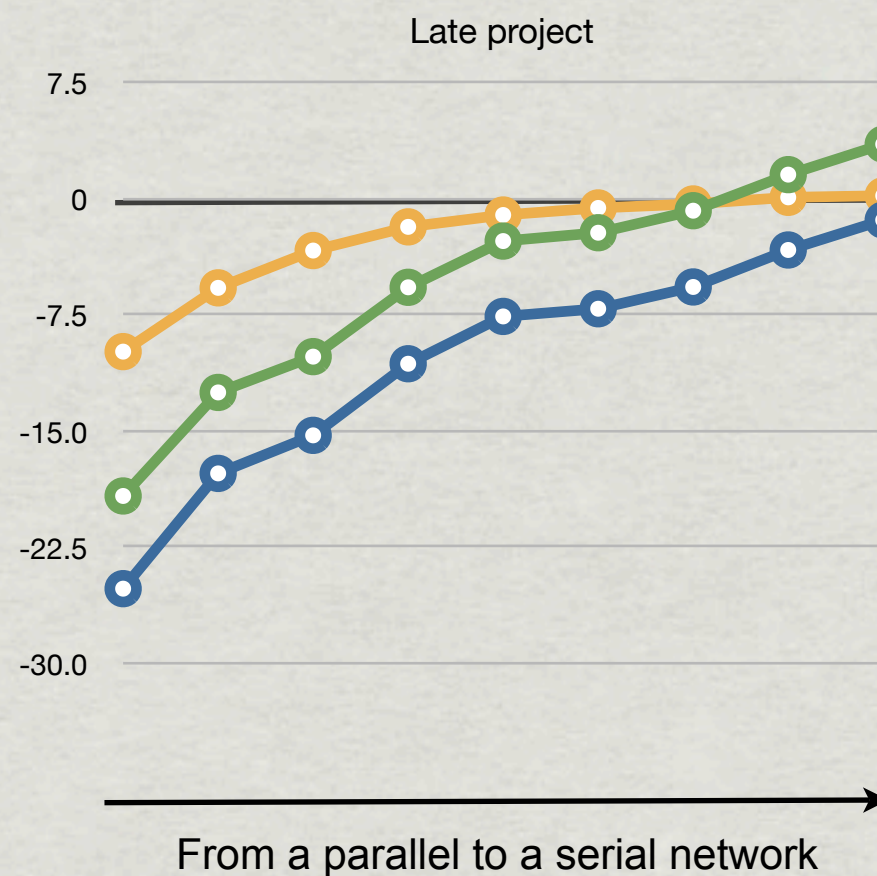
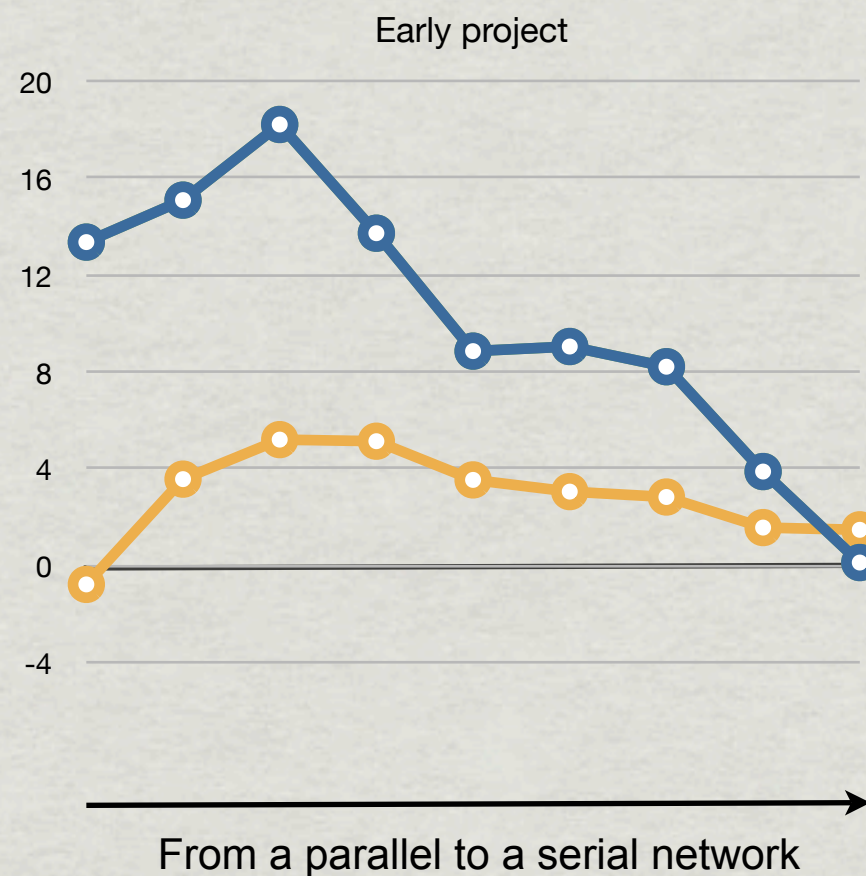
ES < PV and ED

False scenarios
(3, 7)

ES << PV and ED

Results (2)

The network structure has a clear influence on the forecast accuracy



SP low
(parallel networks)
Low accuracy

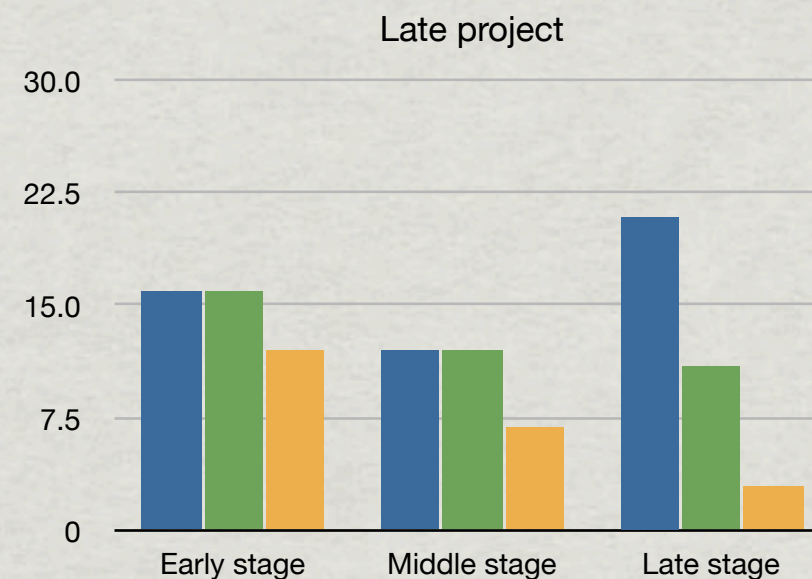
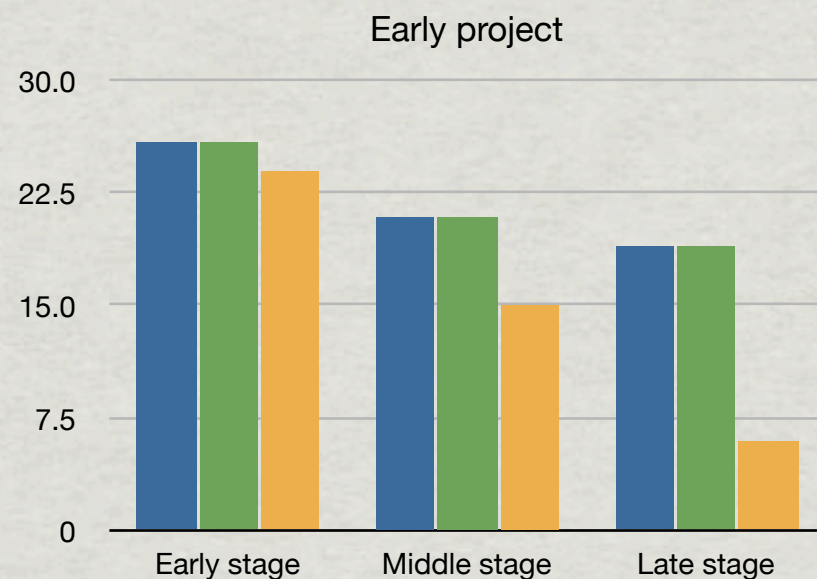
SP high
(serial networks)
High accuracy

● Planned Value
● Earned Duration
● Earned Schedule

Results (3)

Accuracy along the completion stage (beginning, middle or late)

- * All forecasting methods have a relatively low accuracy at the project start. So what?
- * The earned schedule method outperforms the other methods from the beginning of the project
- * All other methods make the quirky mistake from the 50% à 60% percentage completed



■ Planned Value ■ Earned Duration ■ Earned Schedule

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Dynamic drivers of forecast accuracy

Time sensitivity and corrective actions

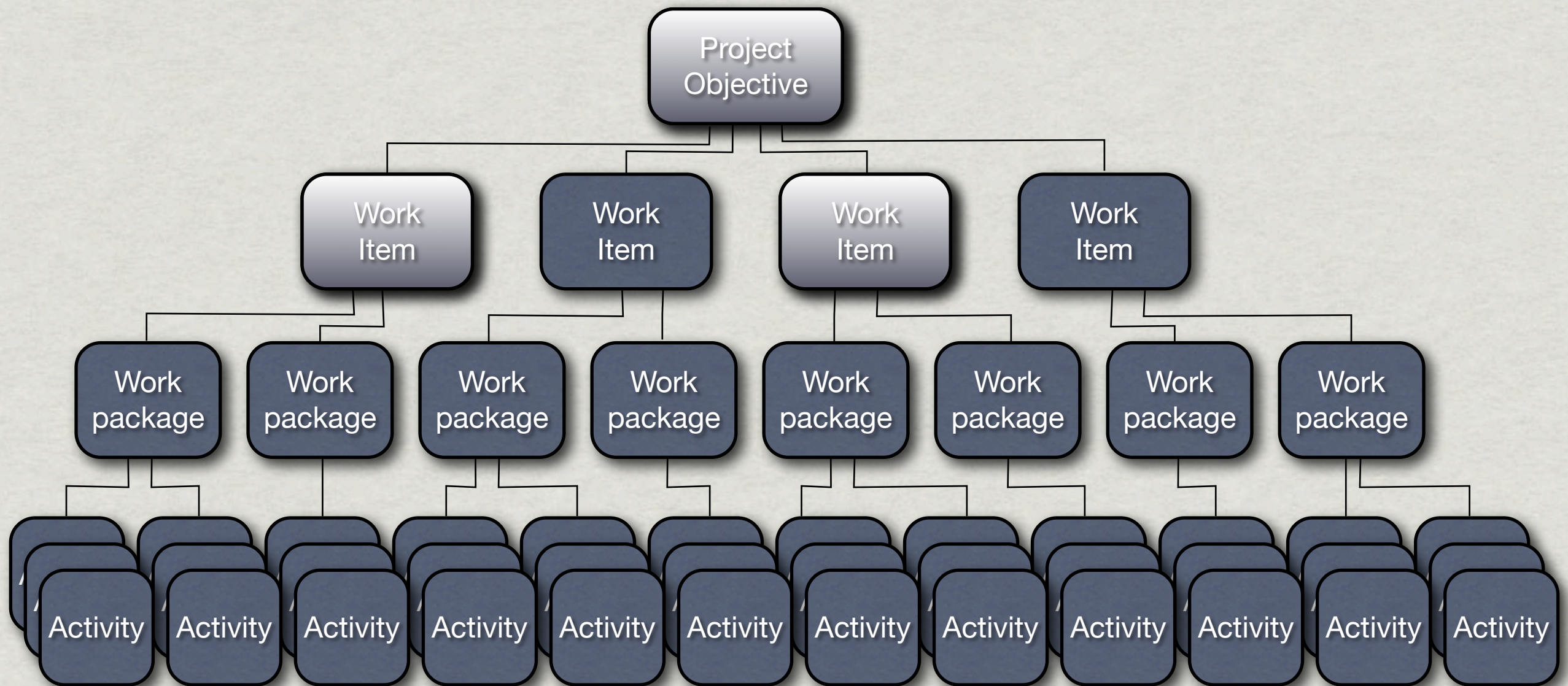
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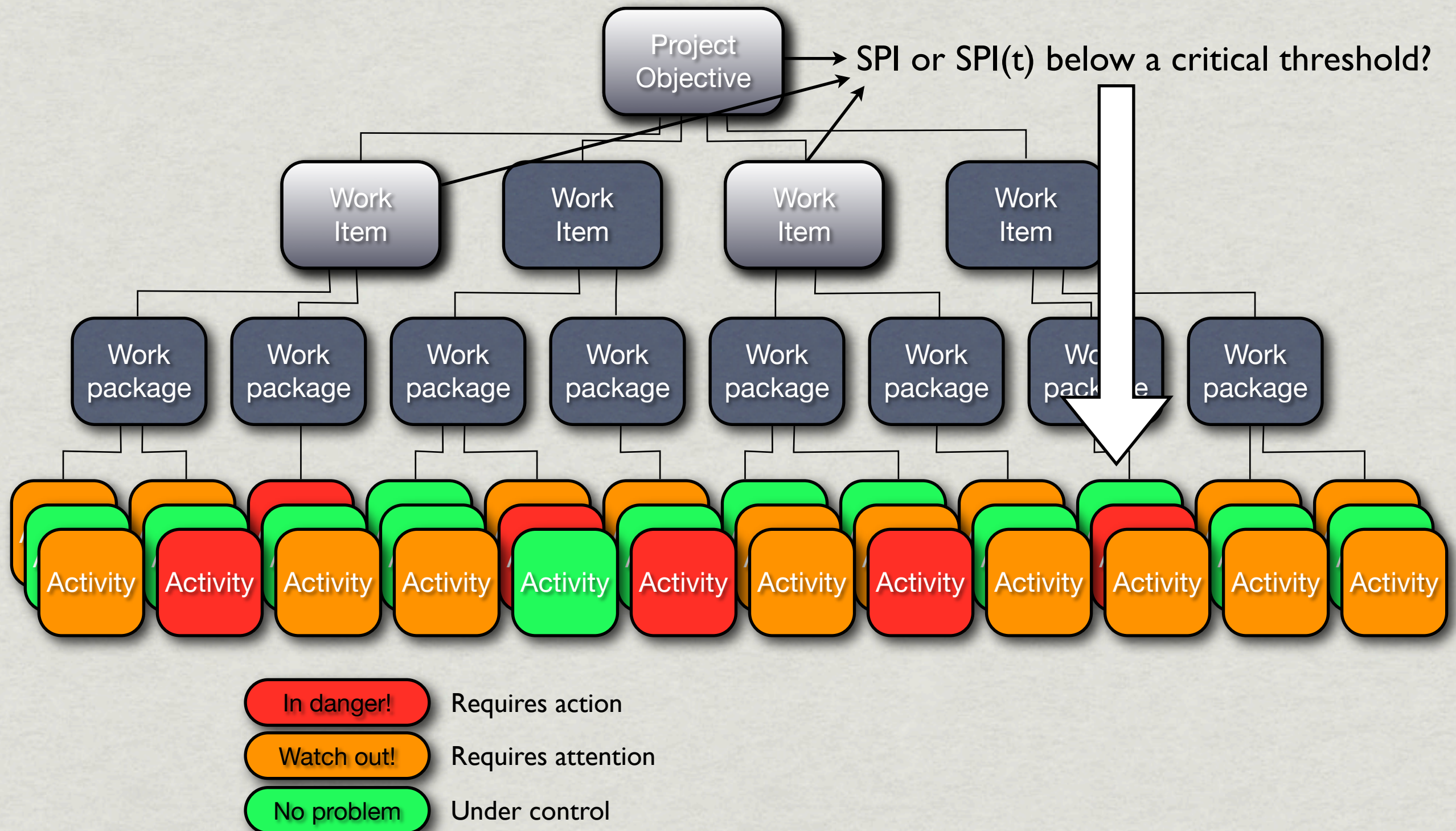
Earned Value Management

= project based tracking approach



Earned Value Management

= project based tracking approach



EVM: when?

- * Project based vs. activity based project tracking approach

Activity based tracking
SPI(t) is unreliable
EAC(t) is inaccurate



100% parallel
network

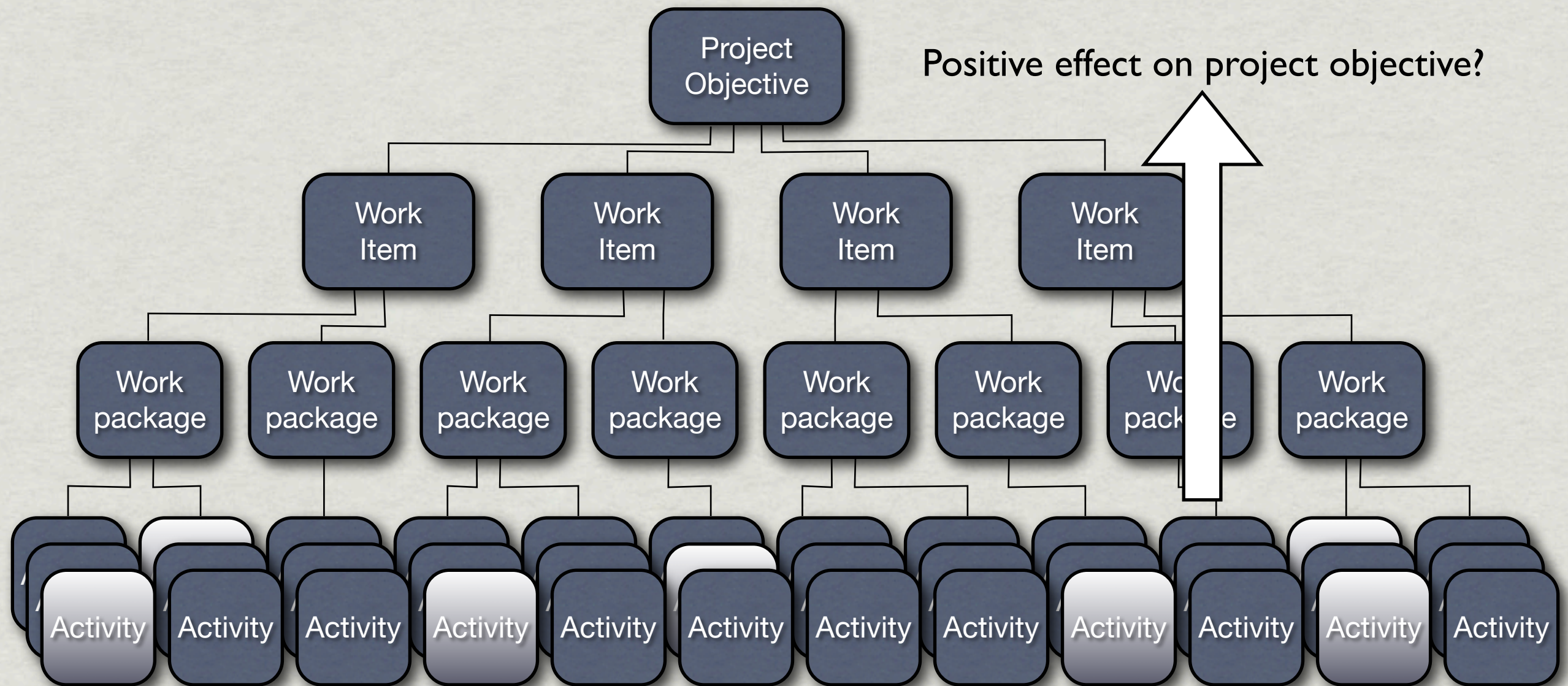
Project based tracking
SPI(t) is reliable
EAC(t) is accurate



100% serial
network

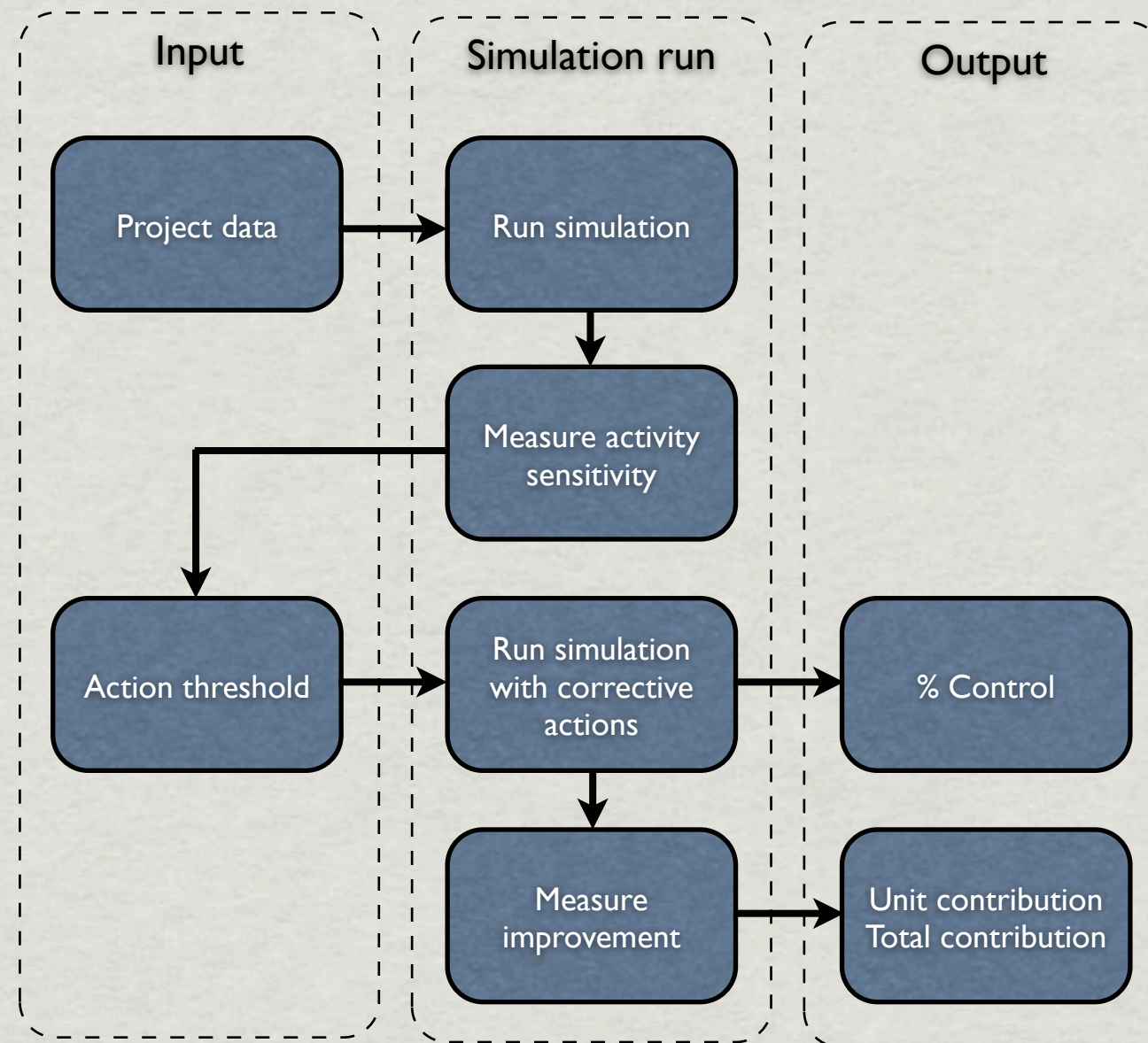
Schedule Risk Analysis

= activity based tracking approach



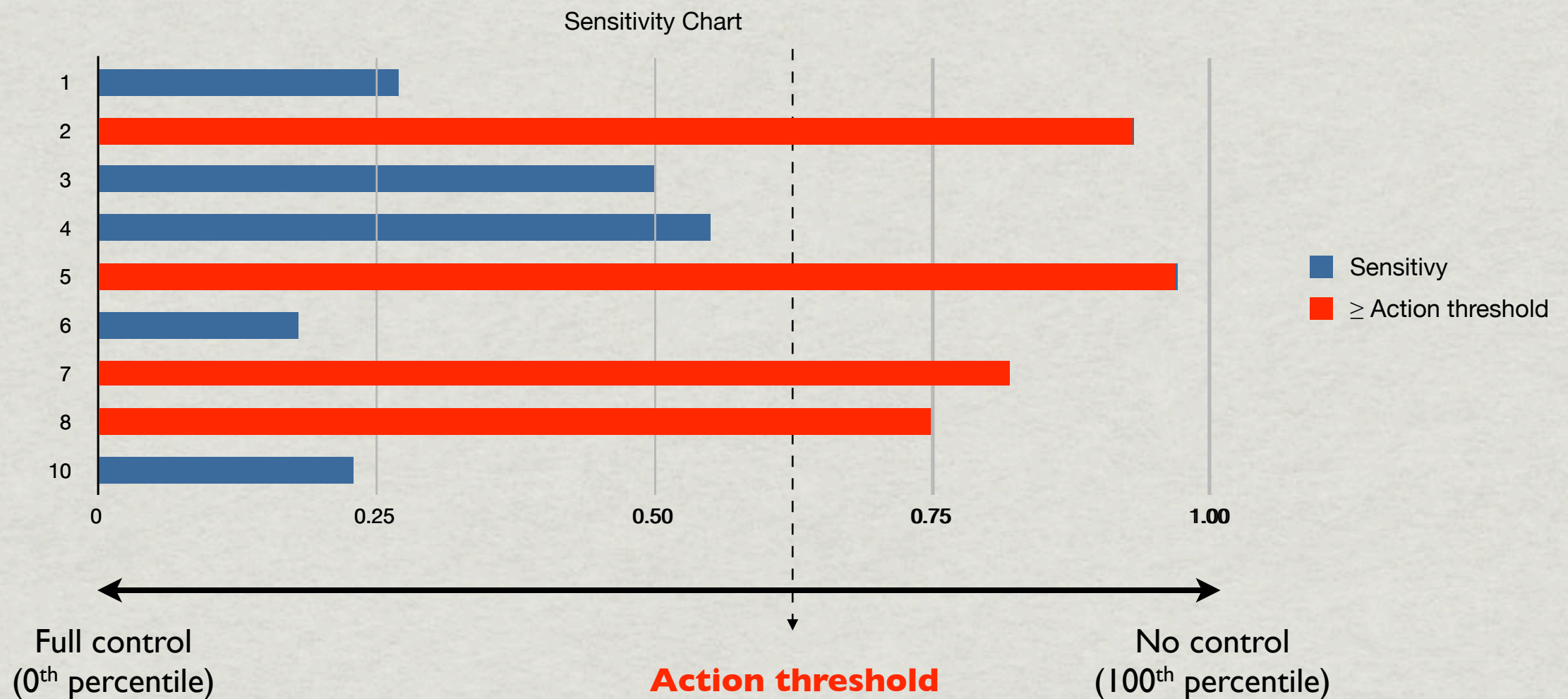
Individual activity control as a trigger for corrective actions
= Obtain with the minimal effort the maximal return!

Simulation study



Management's focus

- * Action threshold as a function of activity sensitivity
- * Determines the %Control



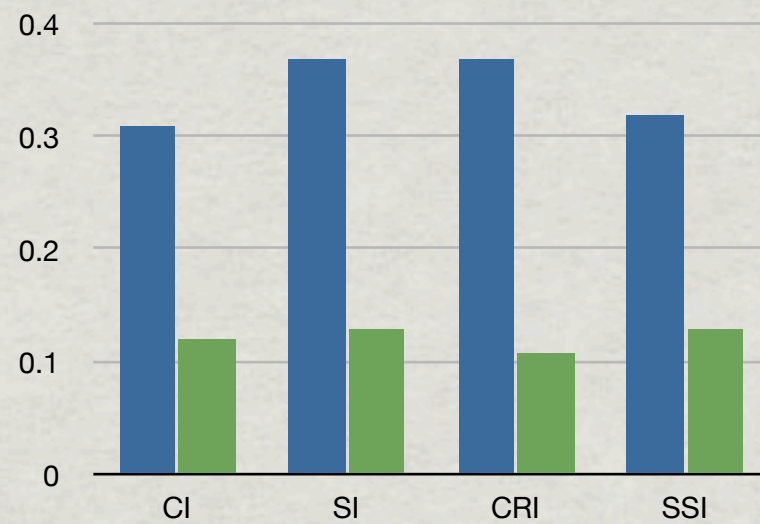
Results

Activity based tracking

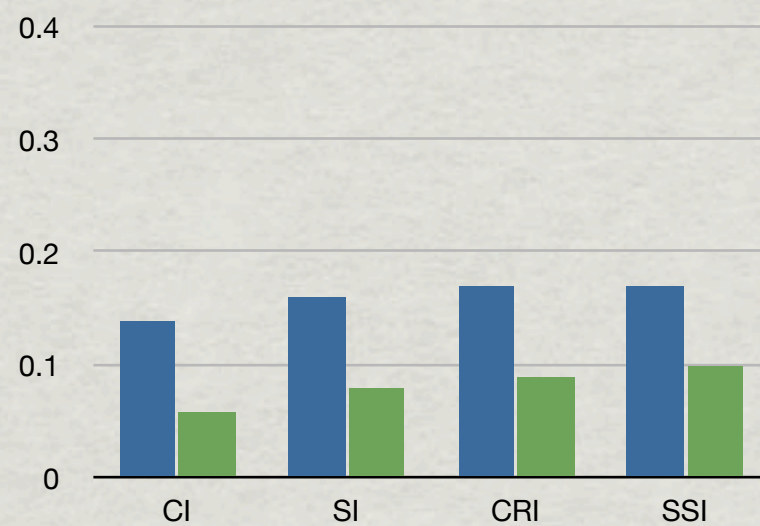
SPI(t) is unreliable
EAC(t) is inaccurate



low SP - low action threshold



low SP - high action threshold

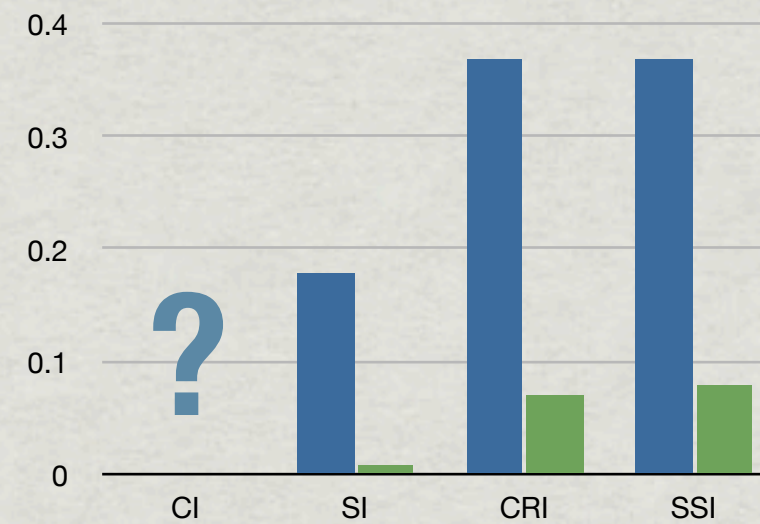


Project based tracking

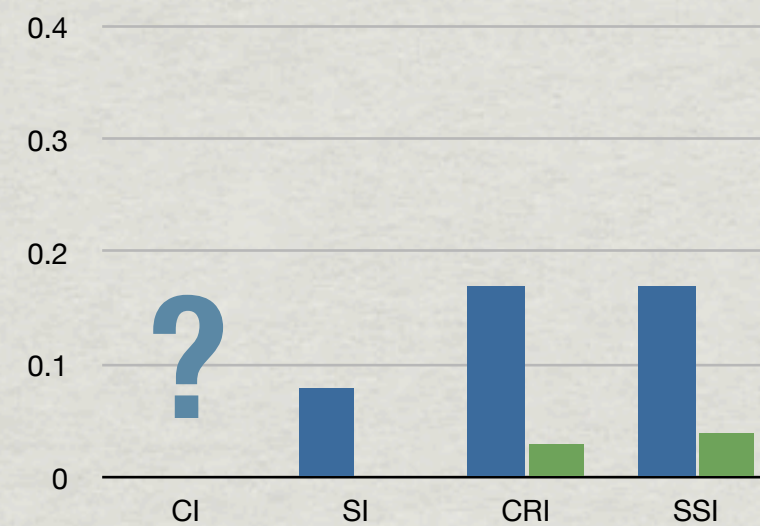
SPI(t) is reliable
EAC(t) is accurate



high SP - low action threshold



high SP - high action threshold



%C
TC

An EVM introduction



The EV terminology



A case study



The research project



Static drivers of forecast accuracy

Dynamic drivers of forecast accuracy

Time sensitivity and corrective actions

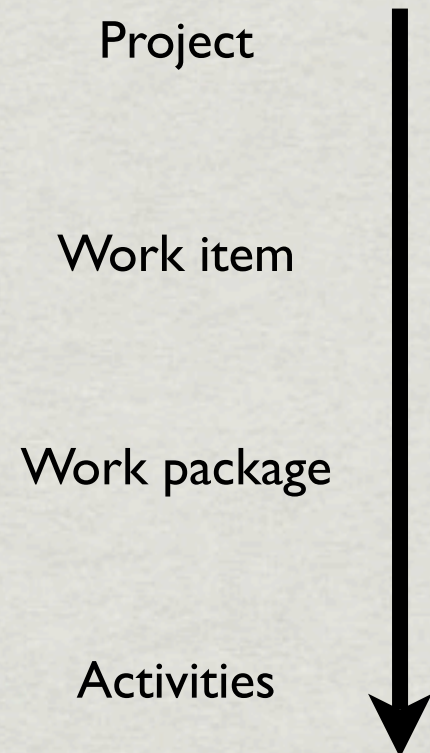
Top-down or bottom-up project tracking

The software

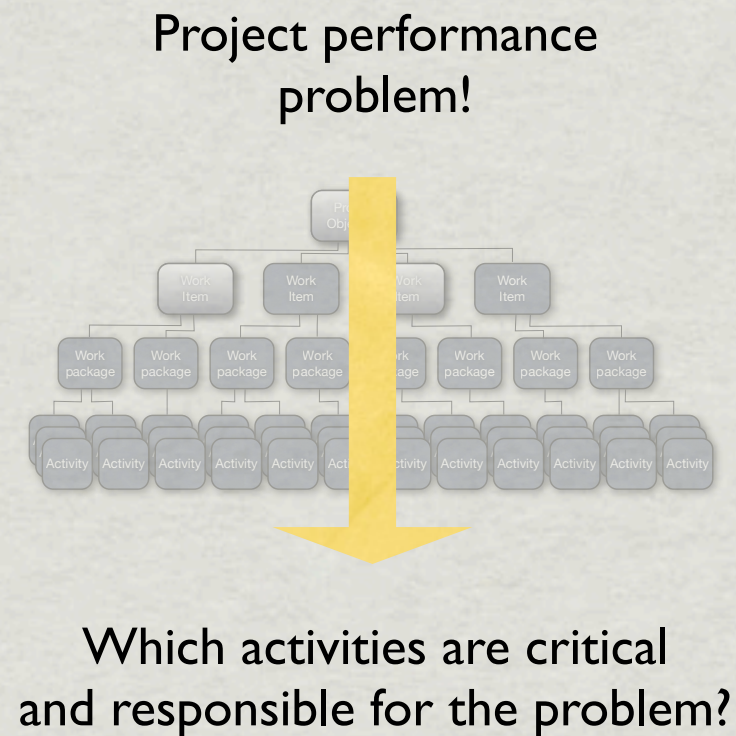


Ideal WBS level?

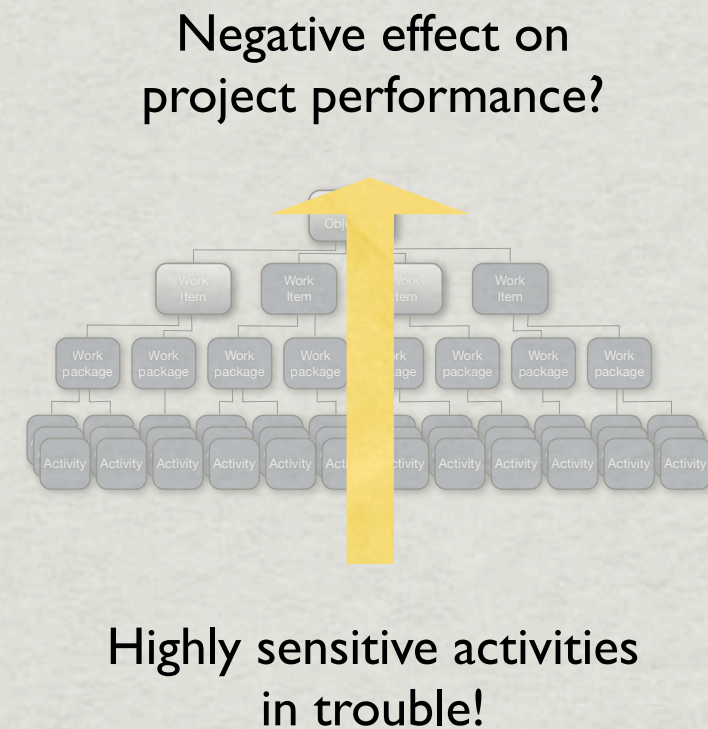
WBS levels

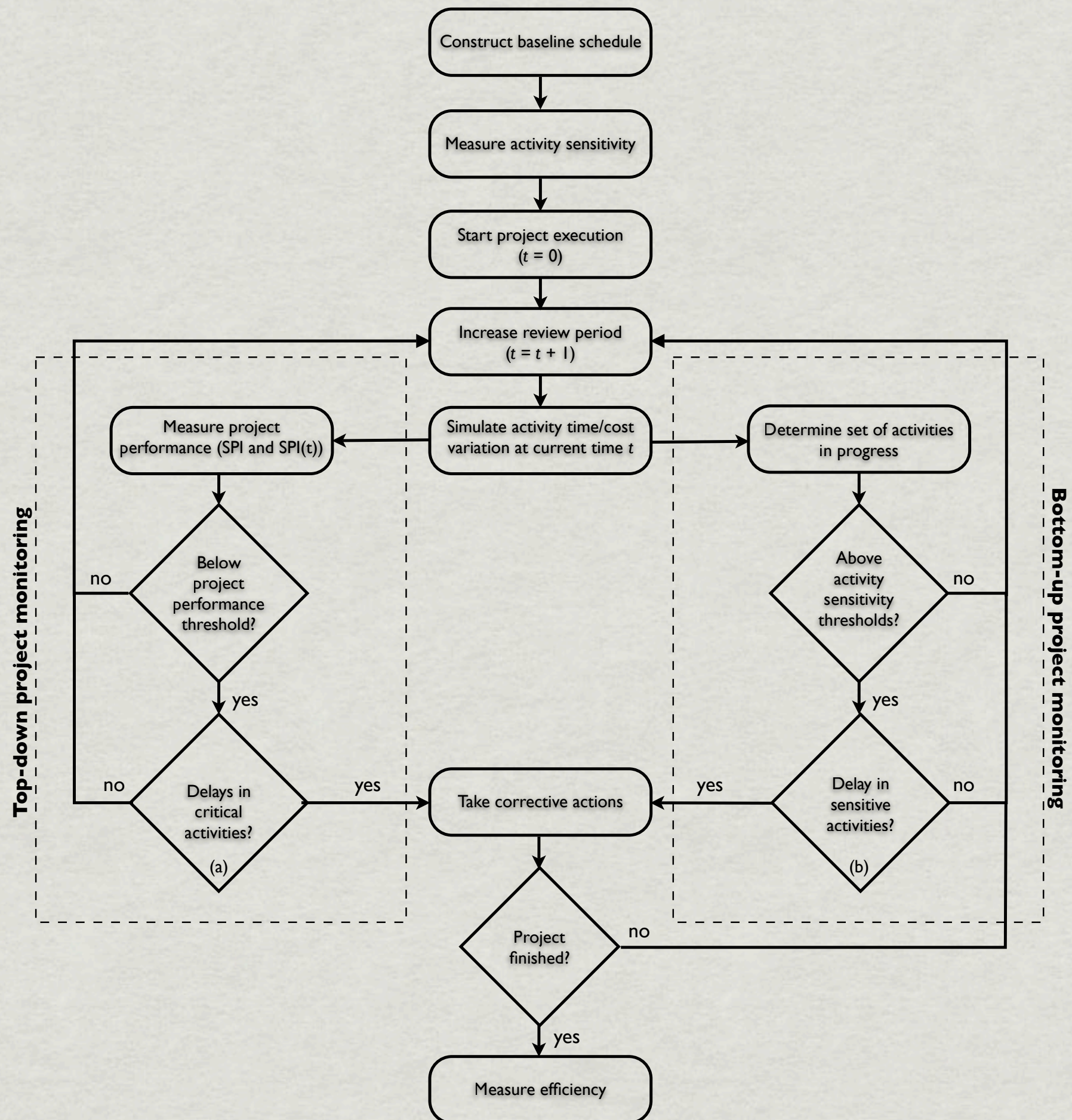


EVM: top-down

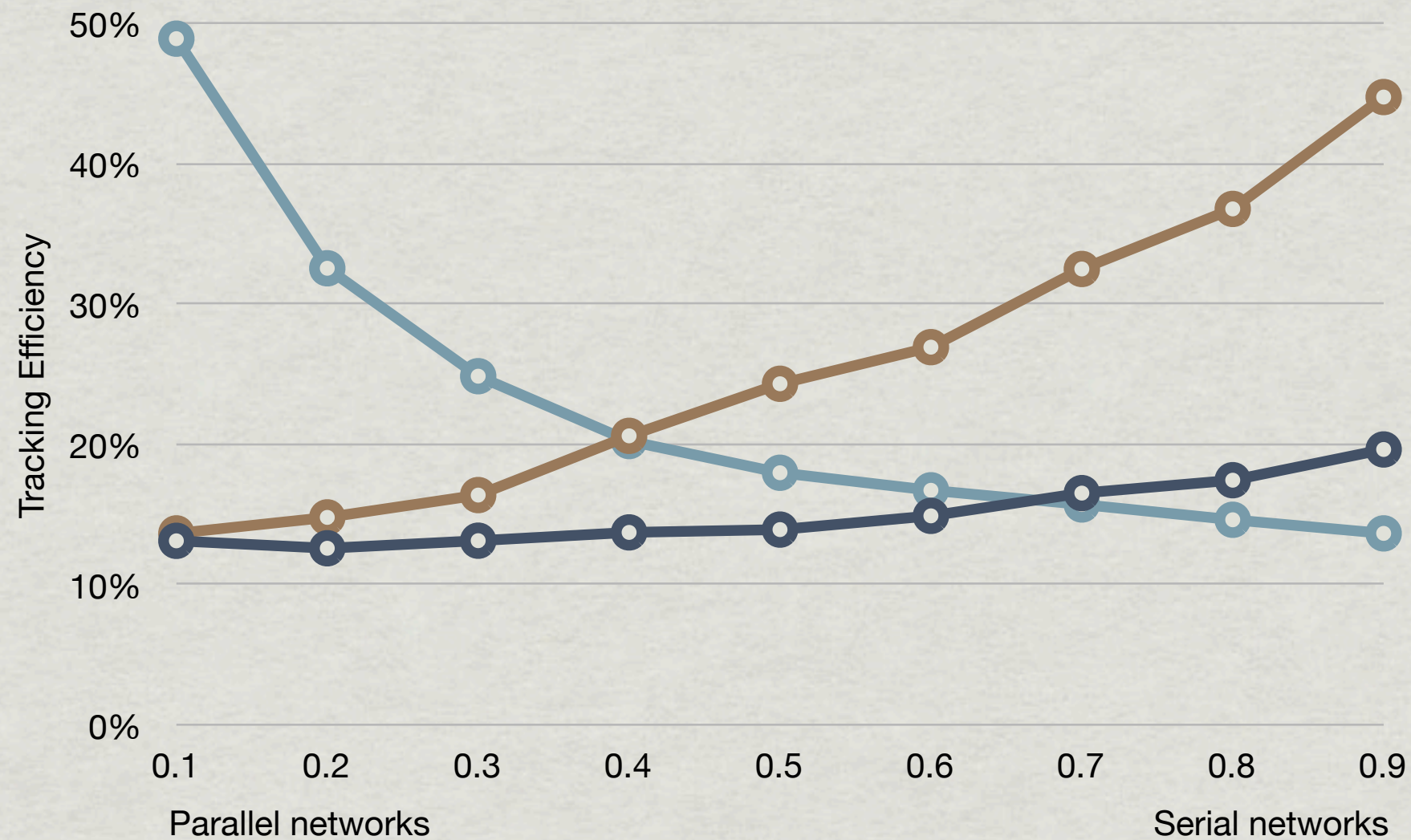


SRA: bottom-up





Results



- TD-SPI -
- TD-SPI(t)
- BU-SRA

Top-down project tracking using EVM with SPI(t) is particularly useful for serial networks
Bottom-up project tracking using SRA is particularly useful for parallel networks

An EVM introduction



The EV terminology



A case study



The research project



Static drivers of forecast accuracy

Dynamic drivers of forecast accuracy

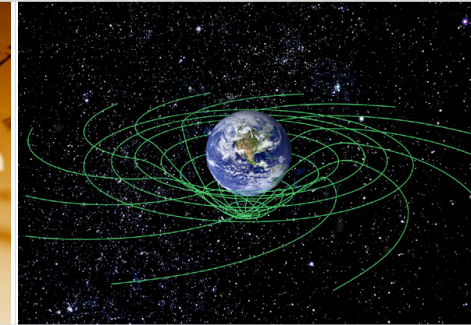
Time sensitivity and corrective actions

Top-down or bottom-up project tracking

The software



ProTrack



CRITERIA	ProTrack	ProTrack	ProTrack	ProTrack
	Standard	Sensitivity Scan	Time Shuttle	Smart Version
Project Planning				
CPM based planning	yes	yes	yes	yes
Network visualization	-	yes	yes	yes
Automatic Project Creation	-	yes	yes	yes
Project simulation options				
Activity Time/Cost Simulation	-	Advanced module	Standard Module	Standard/Advanced modules
Schedule Risk Analysis	-	yes	-	yes
EVM forecast accuracy Analysis	-	-	yes	yes
Project Tracking				
Earned Value and Earned Schedule	yes	yes	yes	yes
Earned Value Forecasting**	yes	yes	yes	yes
Automatic Tracking Generation	-	-	yes	yes
p-factor calculation	-	-	yes	yes
Book "Measuring Time"	-	-	-	yes
Price	299 €	399 €	399 €	599 €

General conclusions
References
Future research avenues



General conclusion

	Activity based project tracking (bottom-up time sensitivity)	Project based project tracking (Top-down earned value)
Parallel project networks	Yes! Focus on a subpart of activity set	No! Inaccurate time forecasts
Serial project networks	No! Focus not possible	Yes! Accurate time forecasts using Earned Schedule

Contact

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* Publications

- * 2 published: International Journal of Project Management, Journal of the Operational Research Society
- * 4 research manuscripts under submission (June 2008)

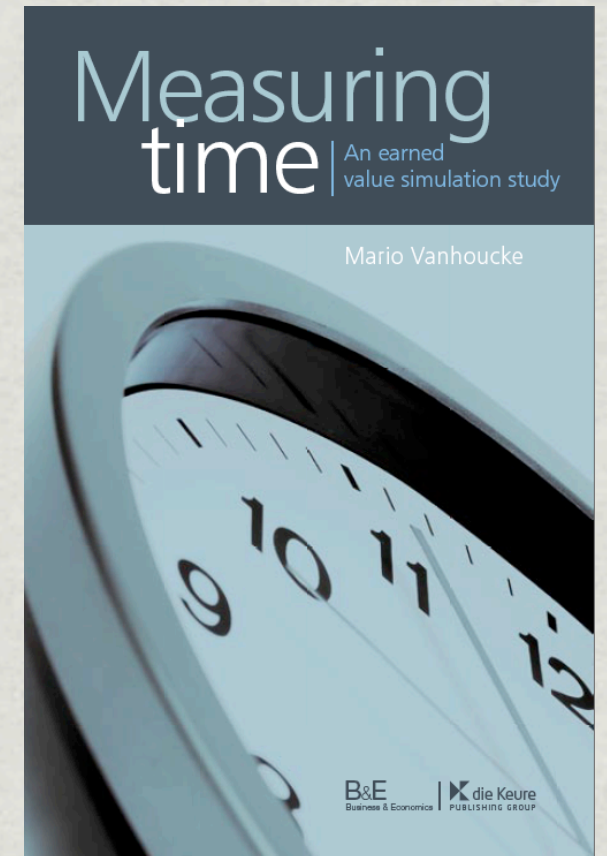
* Book: Measuring time (to appear)

* Software (coming soon)

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