Customer Orientation

Lean Six Sigma

Agile Processes

Project Estimations

Transfer Functions

Autonomous Real-Time Software & Systems Testing

Thomas M. Fehlmann, Zürich
Euro Project Office AG
E: info@e-p-o.com
H: www.e-p-o.com

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ISBSG
Delivering IT Confidence

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Customer Orientation

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Project Estimations

Transfer Functions

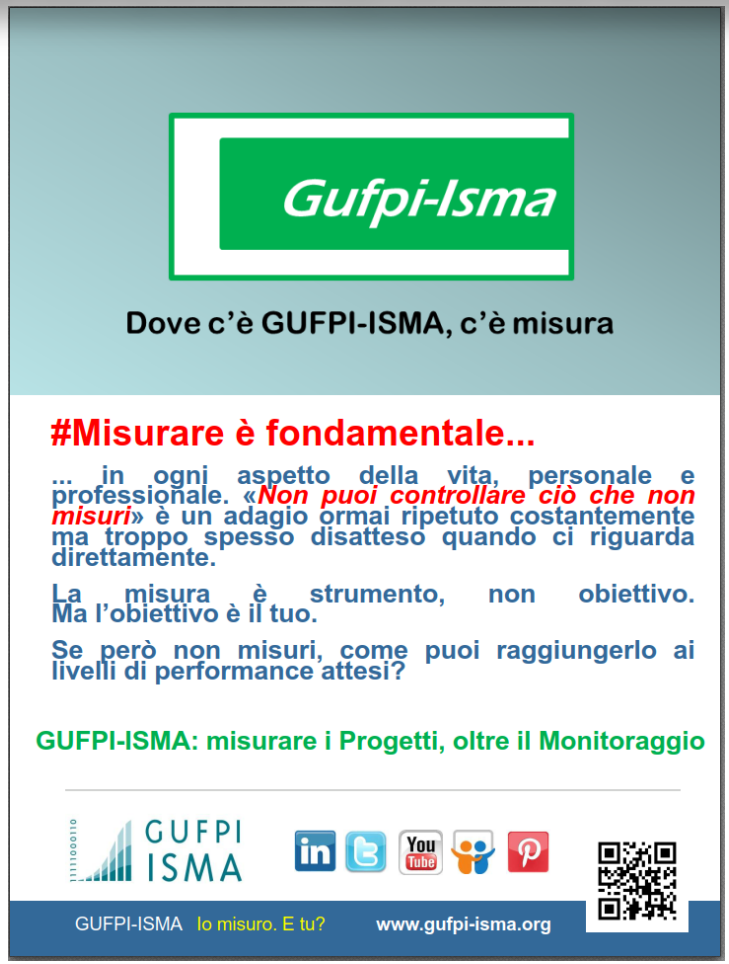
- 1981: Dr. Math. ETHZ
- 1991: Six Sigma for Software Black Belt
- 1999: Euro Project Office AG, Zürich
- 2001: Akao Price 2001 for original contributions to QFD
- 2003: swissICT Expert for Software Metrics
- 2004: Member of the Board QFD Institute Deutschland – QFD Architect
- 2007: CMMI for Software – Level 4 & 5
- 2009: Member of GUFPI-ISMA
- 2011: Net Promoter® Certified Associate
- 2013: Vice-President ISBSG
- 2016: Academic Member of the Athens Institute for Education and Research

GUFPI-ISMA

https://connect.eventtia.com/en/dmz/isma15/website

- Tre **Eventi Metrici** per anno (un giorno)
  - Roma, in maggio
  - Torino, Milano; nel nord, in settembre
  - Napoli, Salerno, Caserta; nel sud, in dicembre

- ISMA 15 a Roma
  - La conferenza internazionale del IFPUG torna in Italia dopo un anno: ISMA15 – che coincide con il 1° #EventoMetrico 2018 – si terrà a Roma dal 9 all'11 Maggio 2018 al Centro Congressi Frentani
  - Gratuito per i soci GUFPI'ISMA; 61€ per i soci del nostro network
  - La partecipazione al giorno della conferenza dà diritto ad 1 CEC IFPUG (programma IFPUG CEP) e a 7 PDU per il programma PMI CCR



Agenda

Test Metrics

Truck Platooning

Real-Time Testing

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Test Metrics

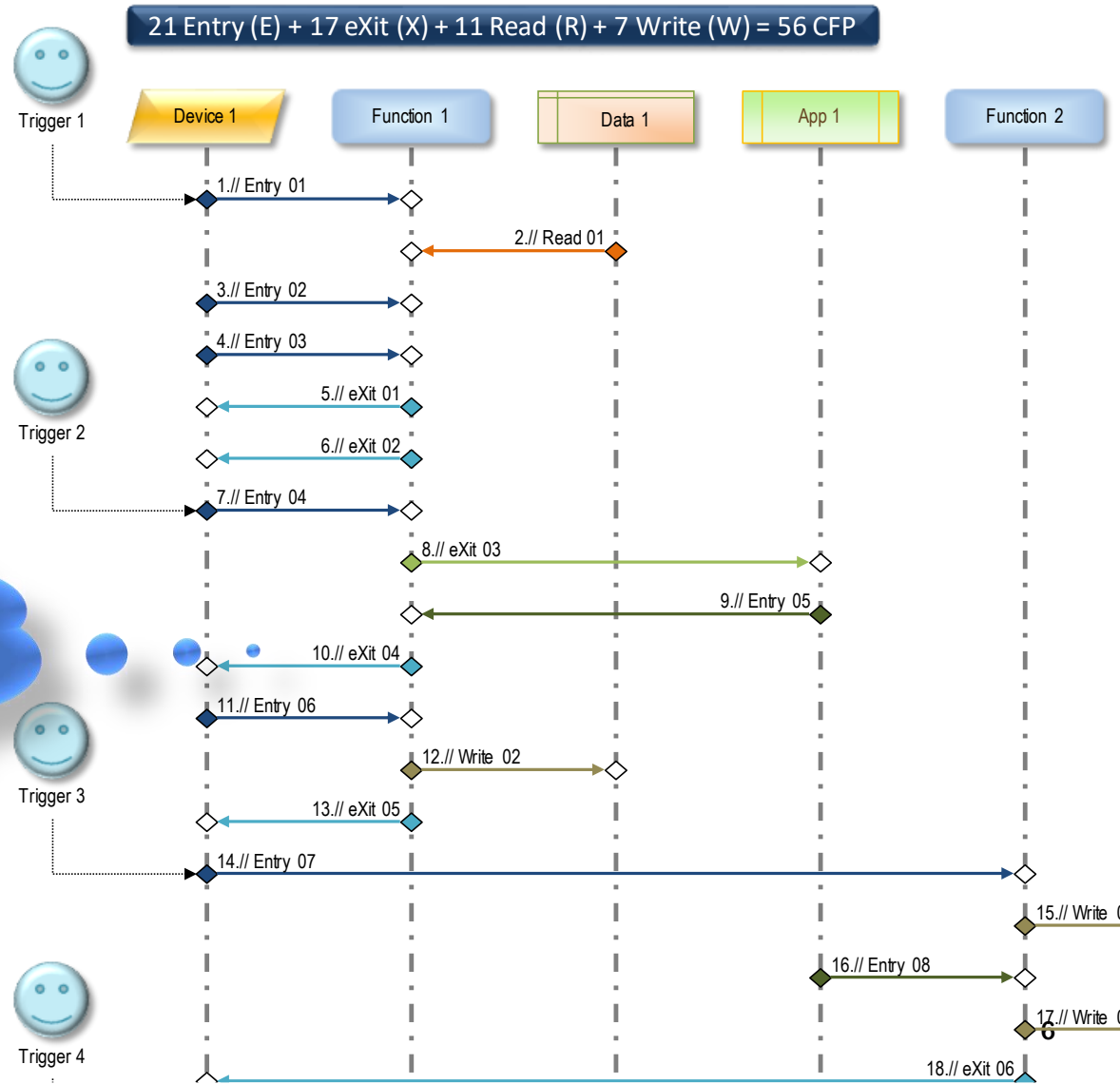
Test Metrics

Real-Time Testing

What is an Application?

- **Objects of Interest:**
  - Devices (user or other system)
  - Functional Process
  - Persistent Data
  - Other Applications
- **Data Movements:**
  - **E**ntry
  - e**X**it
  - **R**ead
  - **W**rite
- Moving **Data Groups** across application within system boundary

Data Movement Map according ISO/IEC 19761 COSMIC



What is a Test?

- A **Software Test** has
  - Several Test Stories
    - Explaining the Value for the Customer
    - Weighted by **Customer's Priority** for the Test Story
- A **Test Story** has
  - Many Test Cases
  - Exploring different aspects – favorable and dismal – of the test story
- A **Test Case** has
  - Test data and test stubs to run the software under test
  - An Outcome
    - Passed: all responses according expectations
    - Failed: at least one test case didn't yield the expected response

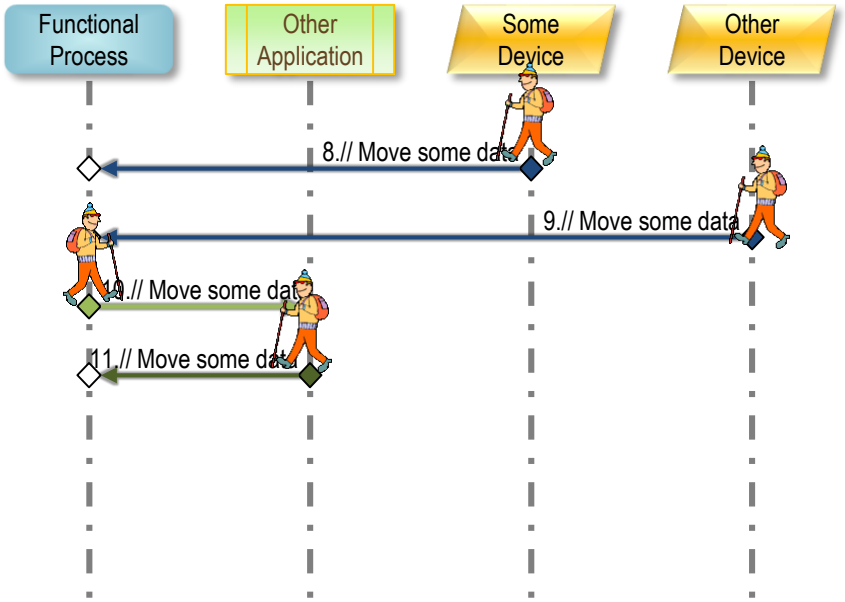
What is a Test Case?

- A **Test Case** has
  - Entry Data (“Test Data”)
    - Explaining the environment for the test case
    - Typically valid, invalid, borderline data
    - Normal and disturbed communication services
  - A known sequence of data movements executed
    - Defining **Test Coverage** and **Test Size**
  - Test Size
    - Every Test Case has a size: the number of data movements executed by the test
    - Total Test Size is the number of data movements executed by all test cases
  - Test Coverage
    - Percentage of data movements covered with test cases

$$\{x_1, x_2, \ldots, x_n\} \rightarrow y$$

Visualizing Software Testing

- Tester sees selected sequences in the Data Movement Map
- Tester can “walk” the data movements when planning or executing tests
  - Makes functionality visible to the development team
  - Localizes defects that impact functionality
  - Supports communication between testers, users, and developers

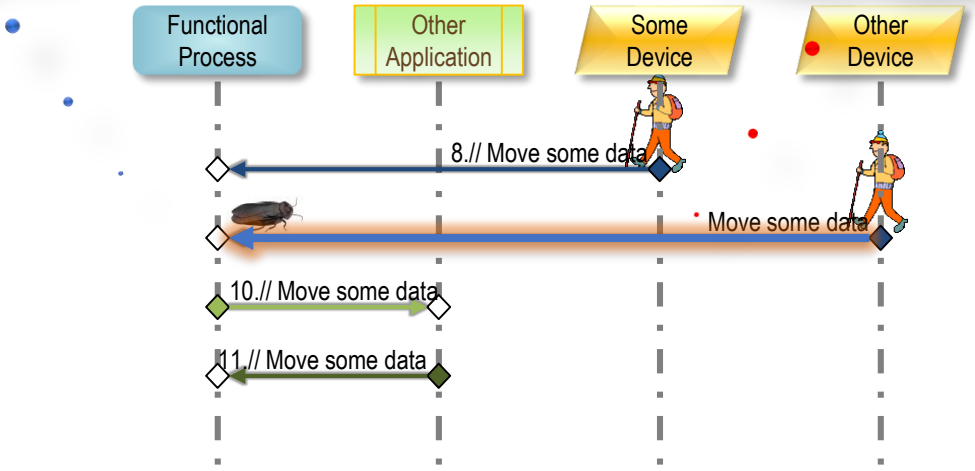


Functionality, Defect Size, and Defect Density

Test Size = 4

Defect Count = 1

- What happens if data movements don't work as expected, have defects instead?
- Testers mark and count data movements where defects have been detected
- Size Metric:
  - **ISO/IEC 19761 COSMIC**



- Functional Size
  - Number of Data Movements needed to implement required functionality
- Test Size
  - Number of Data Movements executed in Tests
- Test Story
  - Collection of Test Cases aiming at certain FURs
- Defect Count
  - Number of Data Movements affected by some defect detected in a test story

Bad Mathematics with Testing

- What is the Size of Software?
  - Lines of (undocumented?) Code?
  - Bug tracking systems refer to code
- What is a Software Defect?
  - An entry in a bug tracking system??
  - Bug tracking systems cannot distinguish multiple bug variances
- What is a Defect Density?
  - Number of bug entries in a bug tracking system per line of code????
  - Are consumers trumped?

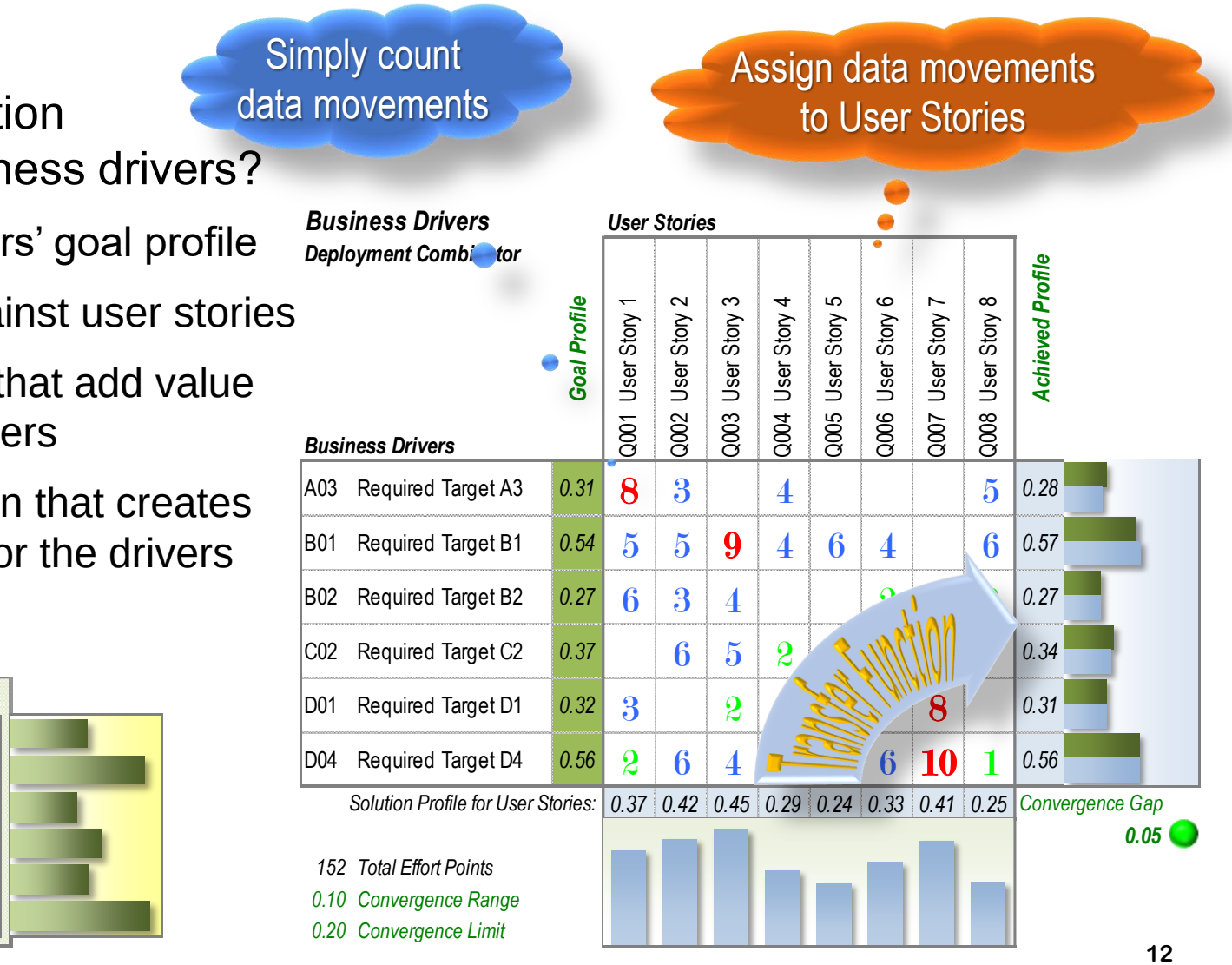
Functional Effectiveness

- How do we know an application implements customer's business drivers?
  - First, find the business drivers' goal profile
  - Deploy business drivers against user stories
  - Count the data movements that add value to some of the business drivers
  - This yields a transfer function that creates an achieved priority profile for the drivers

Simply count data movements

Assign data movements to User Stories

		Business Drivers	Weight	Profile
A	Group A	A03 Required Target A3	13%	0.31
B	Group B	B01 Required Target B1	23%	0.54
		B02 Required Target B2	11%	0.27
C	Group C	C02 Required Target C2	16%	0.37
D	Group D	D01 Required Target D1	13%	0.32
		D04 Required Target D4	24%	0.56



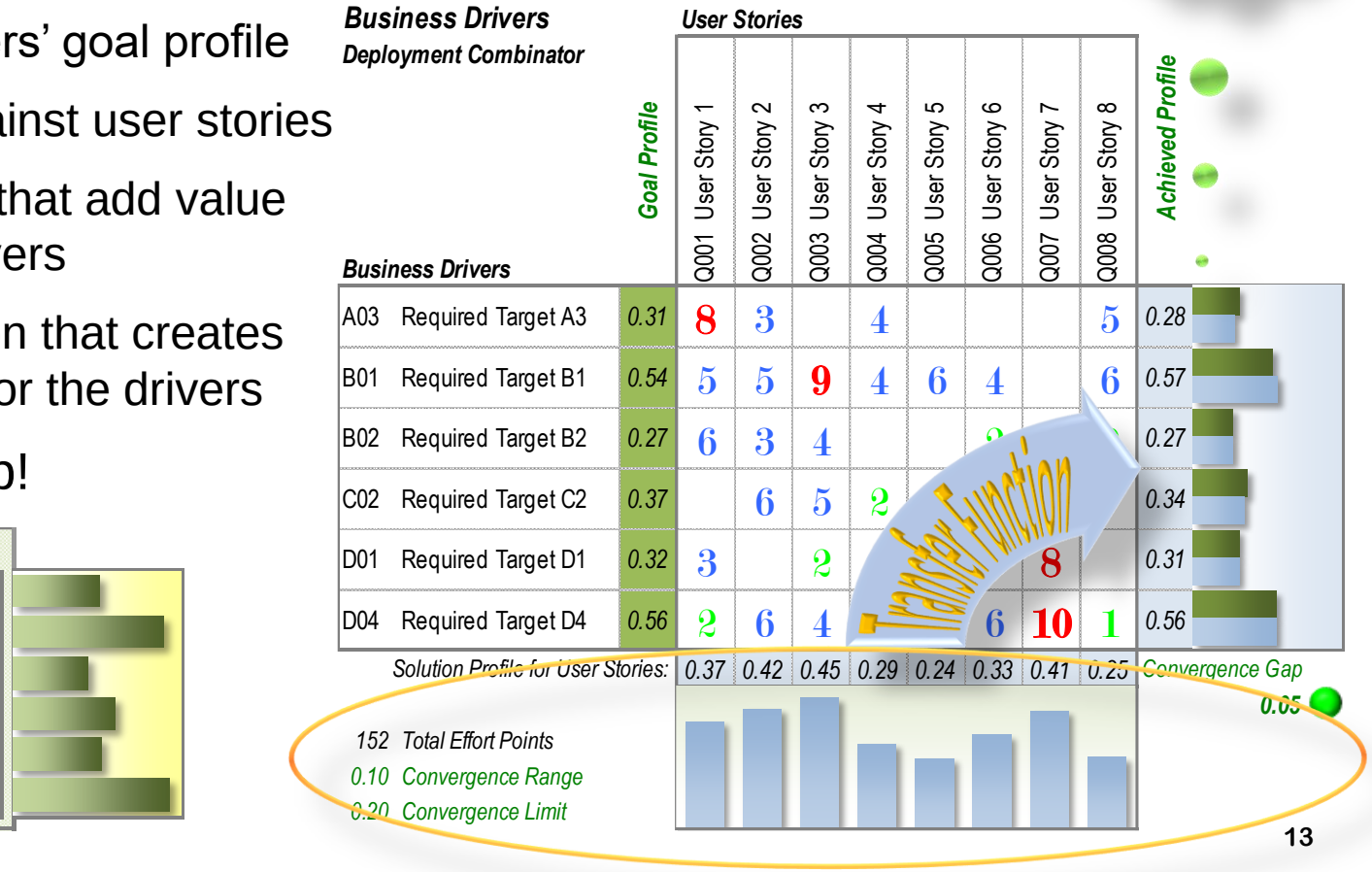
Functional Effectiveness

ISO 16355 QFD

Perfect Fit!

- How do we know an application implements customer's business drivers?
  - First, find the business drivers' goal profile
  - Deploy business drivers against user stories
  - Count the data movements that add value to some of the business drivers
  - This yields a transfer function that creates an achieved priority profile for the drivers
- Check the Convergence Gap!

	Business Drivers		Weight	Profile
A	Group A	A03 Required Target A3	13%	0.31
B	Group B	B01 Required Target B1	23%	0.54
		B02 Required Target B2	11%	0.27
C	Group C	C02 Required Target C2	16%	0.37
D	Group D	D01 Required Target D1	13%	0.32
		D04 Required Target D4	24%	0.56



ISO 16355 QFD

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Test Coverage

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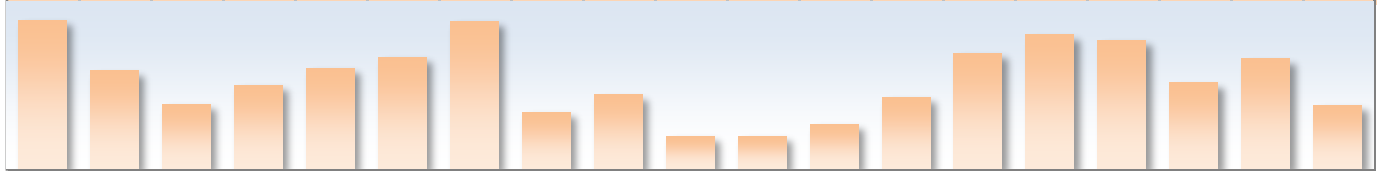
Test Coverage

Deployment Combinator

Total Size of Test Cases in Test Story x_i referring to User Story y_j

User Stories	Goal Test Coverage	Q1-1 Test Story Q1-1	Q1-2 Test Story Q1-2	Q1-3 Test Story Q1-3	Q1-4 Test Story Q1-4	Q2-1 Test Story Q2-1	Q2-2 Test Story Q2-2	Q3-1 Test Story Q3-1	Q3-2 Test Story Q3-2	Q4-1 Test Story Q4-1	Q4-2 Test Story Q4-2	Q4-3 Test Story Q4-3	Q5-1 Test Story Q5-1	Q5-2 Test Story Q5-2	Q6-1 Test Story Q6-1	Q6-2 Test Story Q6-2	Q7-1 Test Stor	Q7-2 Test St	Q8-1 Test S	Q8-2	Achi
Q001 User Story 1	0.37	9	4		4														5	4	0.40
Q002 User Story 2	0.42	4	6	2		5	10														0.40
Q003 User Story 3	0.45	2		4	4	4		12	5												0.46
Q004 User Story 4	0.29					1	2	2		10	5	5	2	2							0.26
Q005 User Story 5	0.24												6	9	2	3					0.21
Q006 User Story 6	0.33														5	7	7	2			0.36
Q007 User Story 7	0.41									1					5	4	7	7	2		0.40
Q008 User Story 8	0.25													2	2	3			7	4	0.25
Ideal Profile for Test Stories:		0.35	0.23	0.15	0.20	0.24	0.26	0.35	0.13	0.18	0.08	0.08	0.10	0.17	0.27	0.32	0.31	0.20	0.26	0.15	Convergence Gap



198 Total Test Size

0.10 Convergence Range

0.20 Convergence Limit

0.06

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Test Metrics

Truck Platooning

Real-Time Testing

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Truck Platooning

- Truck Platooning comprises a number of trucks equipped with state-of-the-art driving support systems – one closely following the other
  - This forms a platoon with the trucks driven by smart technology, and mutually communicating
  - Truck platooning is innovative and full of promise and potential for the transport sector
  - Source: https://www.eutruckplatooning.com

Truck Platooning – State of the Art

- Currently, distances between trucks must be such that a truck can be stopped by its driver when needed
  - This leads to a minimal distance of minimum 22 m at 80 km/h
  - Corresponds to 2 sec reaction time
- An exemption process was needed to allow the 2016 Truck Platooning Challenge to happen
  - 0.5 sec reaction time – 5.5 m minimum distance
  - Six platoons from Sweden and Germany to Rotterdam harbor
- Challenges:
  - Many lessons learned
  - Other traffics' unsafe behavior
  - Unexpected situations at ramps

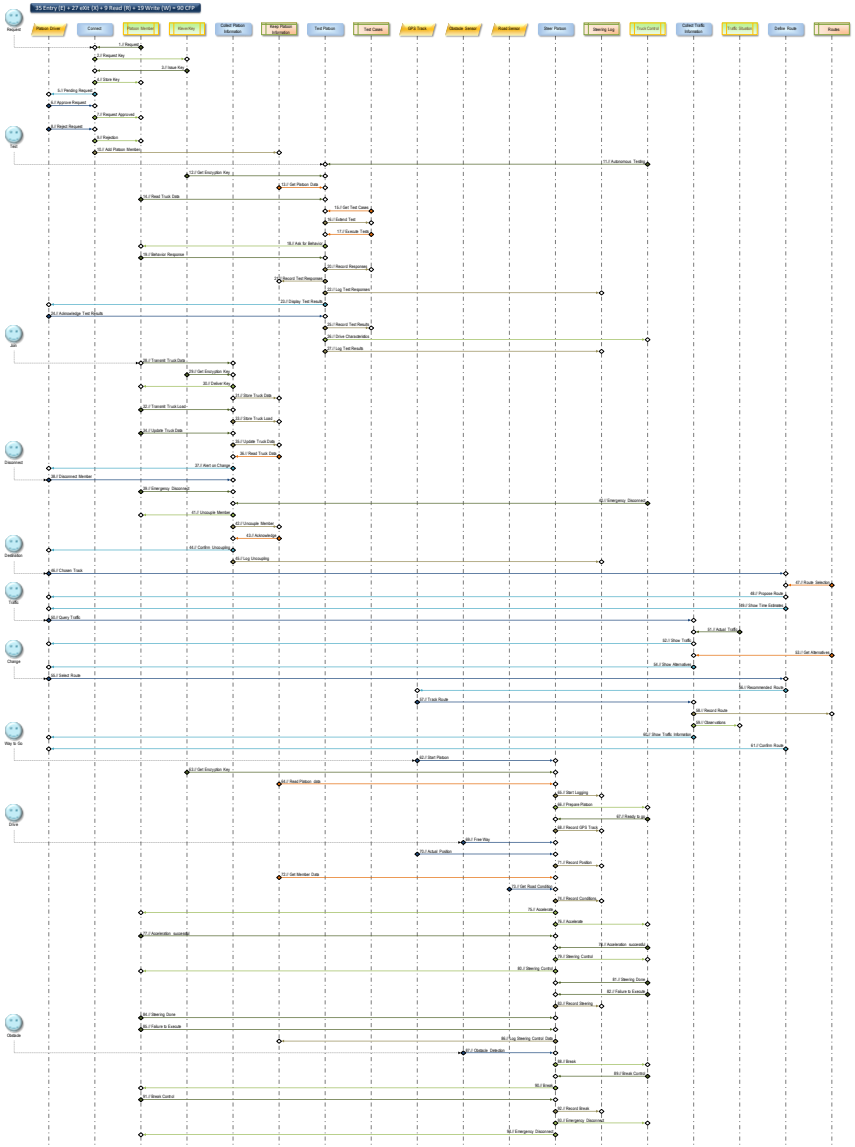
Truck Platooning Challenges

- What happens if two platoons meet on a ramp?
- How do cars or other trucks merge with traffic on a ramp?
- What if road condition changes suddenly? E.g., with rain or snow?

Truck Platooning Software

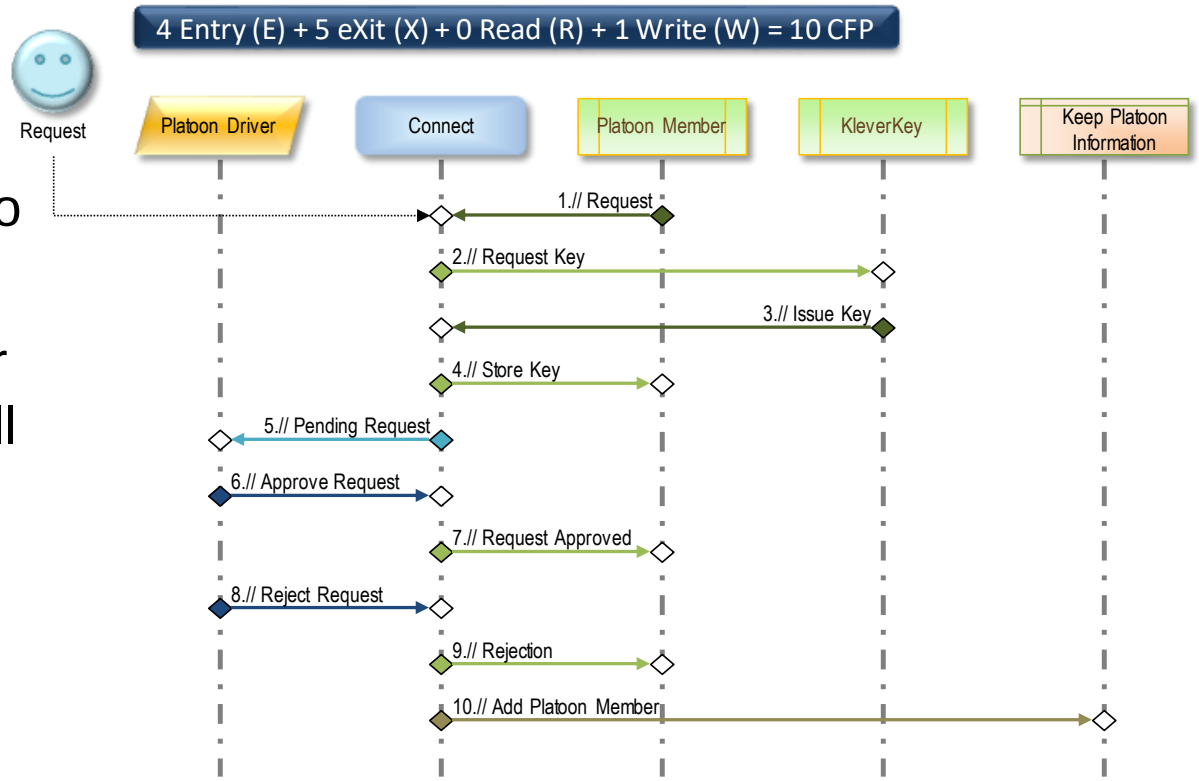
31 Entry (E) + 25 eXit (X) + 9 Read (R) + 19 Write (W) = 84 CFP

- Not too complex
- Must know parameters of other trucks
  - Weight
  - Load
  - Motorization
  - Brake efficiency
- Risks for safety with other traffic
  - Detect unexpected situations
  - Protect against communication loss
- Risks for privacy



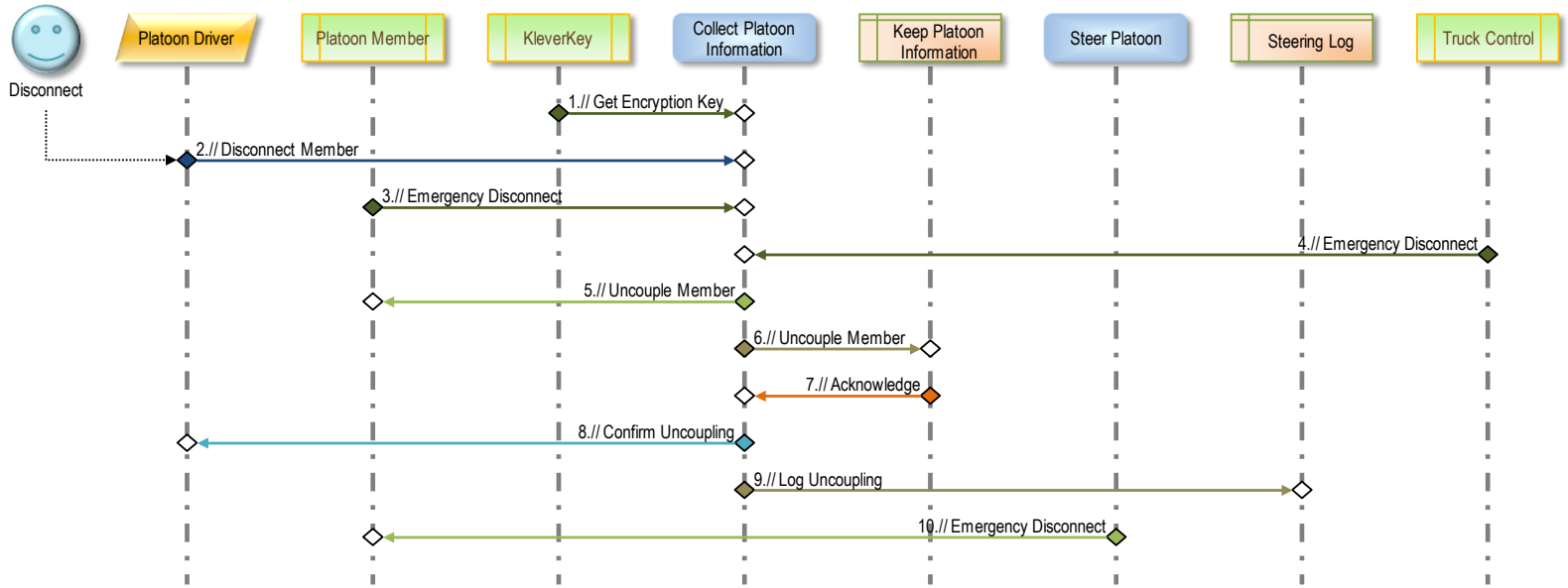
Connect to Platoon

- A platoon member software issues a connection request
- Functional process **Connect** requests a key from KleverKey to encrypt all communications
- Store key in the platoon member application for further use with all communication
- There is an automatic check whether the requesting software is capable to support platooning
- Request is approved or rejected by platoon driver



Disconnect from Platoon

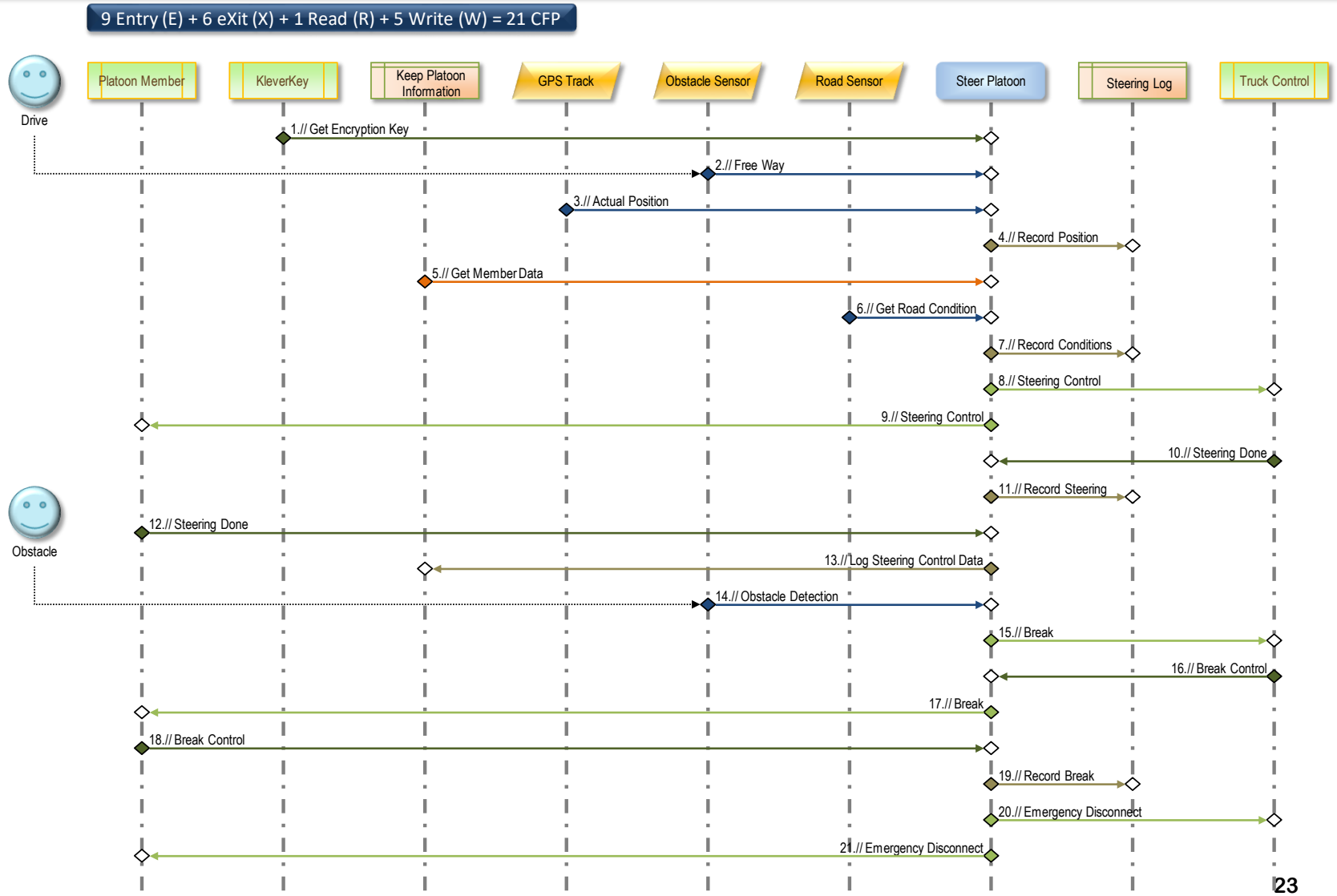
4 Entry (E) + 3 eXit (X) + 1 Read (R) + 2 Write (W) = 10 CFP



- Disconnect can originate
  - By the platoon driver
  - By some of the platoon members
  - While steering the platoon and encountering an obstacle
- Platoon member must take over control
  - By a human driver, or
  - By its own autonomous truck control

Drive Around Obstacles

- Head driver leads the platoon
- **Steer Platoon**, acceleration and deceleration require reliable and encrypted communication to platoon members
- Breaking must be watched and recorded for future learning



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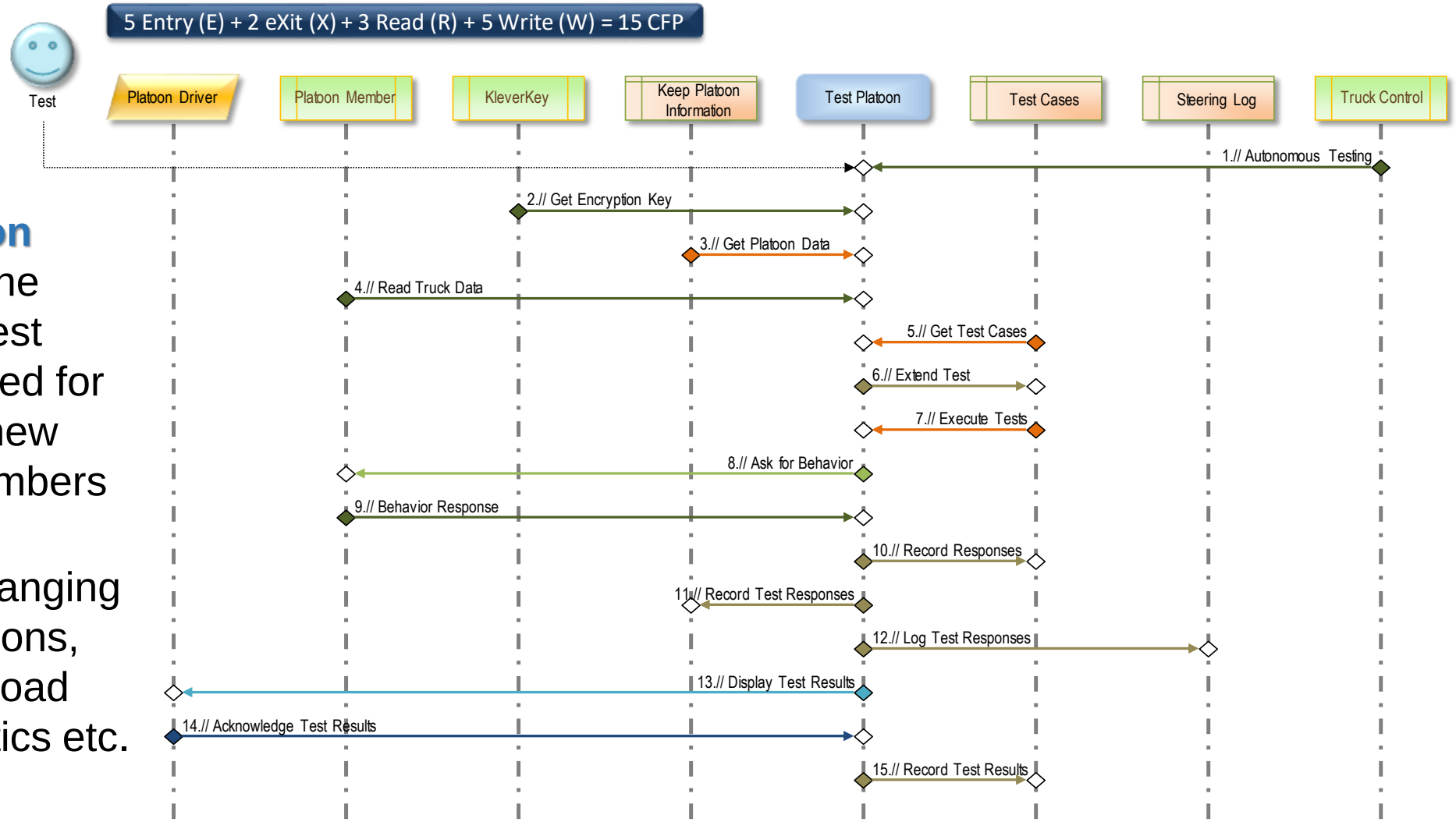
Autonomous Testing while Running the Platoon

- The functional process **Test Platoon** generates the additional test cases needed for assessing new platoon members

- Adapt to changing road conditions, truck data, load characteristics etc.



Extending Test Cases

Level 1 Parametrization of same controls	• Existing test cases without changing logic, changing test data only
Level 2 New controls, same response	• New controls with new test data but response as before
Level 3 Same controls, different response	• Same controls with new test data generate new response
Level 4 New controls, new response	• Unrelated with previous test cases but still within the same test story with a new, unprecedent response

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Real-Time Testing

Autonomous Real-Time Testing – Step 1

- Analyze Customer's Needs
  - Identify topics
  - Make sure they are relevant
  - And can be influenced
- Get a Response Profile
  - Use **Analytic Hierarchy Process**
  - Use **Net Promoter® Score**
  - Use **Go to the Gemba**
  - Ask Customers and Users
  - Combine all them for getting the **Voice of the Customer**

Business Drivers Get Priority

	Business Drivers	Attributes	Weight	Profile
A Group A	A03 Expected Response A3	*Attribute A03-1*	*13%*	*0.31*
B Group B	B01 Expected Response B1	*Attribute B01-1*	*23%*	*0.54*
	B02 Expected Response B2	*Attribute B02-1*	*11%*	*0.27*
C Group C	C02 Expected Response C2	*Attribute C02-1*	*16%*	*0.37*
D Group D	D01 Expected Response D1	*Attribute D01-1*	*13%*	*0.32*
	D04 Expected Response D4	*Attribute D04-1*	*24%*	*0.56*

AHP Priorities

Get Priority	A Group A	B Group B	C Group C	D Group D	Weight	Ranking	Profile
A Group A	1	1/5	2	1/3	*16%*	*4*	*0.31*
B Group B	5	1	1/2	1/3	*23%*	*2*	*0.44*
C Group C	1/2	2	1	1/2	*20%*	*3*	*0.37*
D Group D	3	3	2	1	*41%*	*1*	*0.76*

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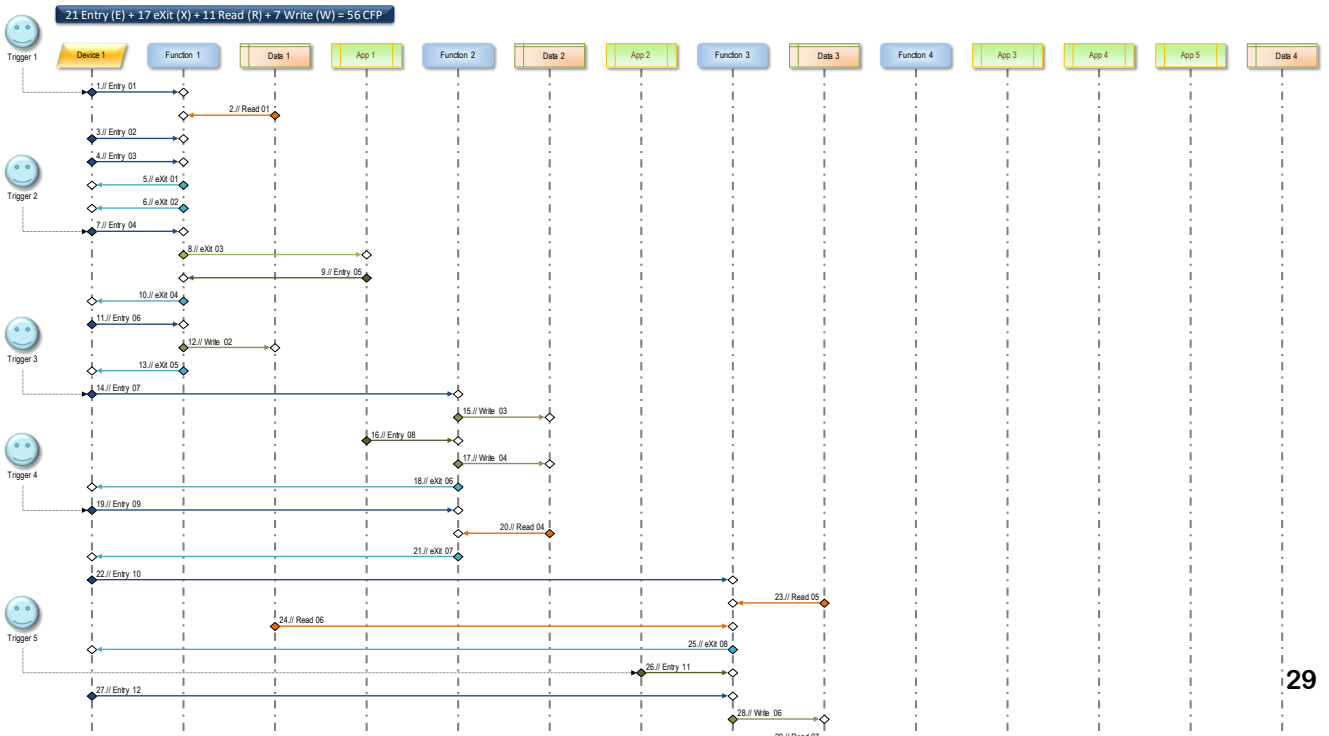
Autonomous Real-Time Testing – Step 2

- Get User Stories
  - Who wants it?
  - What exactly do they want?
  - How important is it?
  - What's the purpose?
- Draw a Data Movement Map
  - What are the Objects?
  - What data is moved?
  - How important are the data?
  - How vulnerable is data?

User Stories

	User Stories Topics	As a ... [functional user]	I want to ... [get something done]	such that ...[quality characteristic]	so that ... [value or benefit]	Priority Weight	Priority Profile
1)	Q001 User Story 1	User	do something	something happens	it's valuable	13%	0.37
2)	Q002 User Story 2	User	do something	something happens	it's valuable	15%	0.42
3)	Q003 User Story 3	User	do something	something happens	it's valuable	16%	0.45
4)	Q004 User Story 4	User	do something	something happens	it's valuable	10%	0.29
5)	Q005 User Story 5	User	do something	something happens	it's valuable	9%	0.24
6)	Q006 User Story 6	User	do something	something happens	it's valuable	12%	0.33
7)	Q007 User Story 7	User	do something	something happens	it's valuable	15%	0.41
8)	Q008 User Story 8	User	do something	something happens	it's valuable	9%	0.25

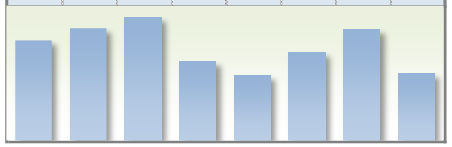


Autonomous Real-Time Testing – Step 3

- Map Data Movements to User Stories
  - Why do you use which data?
  - Which data movement functionality supports specific user stories?
- Count data movements per user story
  - Is the functionality needed?
  - For which user story?
  - Does the convergence gap close?
    - If not, add more data movements to the user story's support count
    - Repeat until the convergence gap closes

Business Drivers — **Deployment Combinator** — **User Stories**

Business Drivers	Goal Profile	Q001 User Story 1	Q002 User Story 2	Q003 User Story 3	Q004 User Story 4	Q005 User Story 5	Q006 User Story 6	Q007 User Story 7	Q008 User Story 8	Achieved Profile
A03 Expected Response A3	0.31	8	3		4				5	0.28
B01 Expected Response B1	0.54	5	5	9	4	6	4		6	0.57
B02 Expected Response B2	0.27	6	3	4			2		2	0.27
C02 Expected Response C2	0.37		6	5	2		2	5		0.34
D01 Expected Response D1	0.32	3		2		4	3	8		0.31
D04 Expected Response D4	0.56	2	6	4	5	2	6	10	1	0.56
Solution Profile for User Stories:		0.37	0.42	0.45	0.29	0.24	0.33	0.41	0.25	Convergence Gap



152 Total Effort Points
0.10 Convergence Range
0.20 Convergence Limit

Autonomous Real-Time Testing – Step 4

- Map Test Stories to User Stories
  - A test story supports more one or than one user story with different impact
  - This is an expert judgment, not a count, not automatic
  - It is testers' expertise to select enough and relevant test stories
- Add Test Cases
  - Identify the data movements needed to execute each test case
  - Count the number of data movements
  - Repeat until convergence gap closes such that test stories cover user stories

Test Coverage Deployment Combinator / User Stories	Goal Test Coverage	Q1-1 Test Story	Q1-2 Test Story	Q1-3 Test Story	Q1-4 Test Story	Q2-1 Test Story	Q2-2 Test Story	Q3-1 Test Story	Q3-2 Test Story	Q4-1 Test Story	Q4-2 Test Story	Q4-3 Test Story	Q5-1 Test Story	Q5-2 Test Story	Q6-1 Test Story	Q6-2 Test Story	Q7-1 Test Story	Q7-2 Test Story	Q8-1 Test Story	Q8-2 Test Story	Achieved Coverage
Q001 User Story 1	0.37	9	4		4														5	4	0.40
Q002 User Story 2	0.42	4	6	2		5	10														0.40
Q003 User Story 3	0.45	2		4	4	4		12	5												0.46
Q004 User Story 4	0.29					1	2	2		10	5	5	2	2							0.26
Q005 User Story 5	0.24												6	9	2	3					0.21
Q006 User Story 6	0.33														5	7	7	2			0.36
Q007 User Story 7	0.41									1					5	4	7	7	2		0.40
Q008 User Story 8	0.25													2	2	3			7	4	0.25
Ideal Profile for Test Stories:		0.35	0.23	0.15	0.20	0.24	0.26	0.35	0.13	0.18	0.08	0.08	0.10	0.17	0.27	0.32	0.31	0.20	0.26	0.15	Convergence Gap 0.06

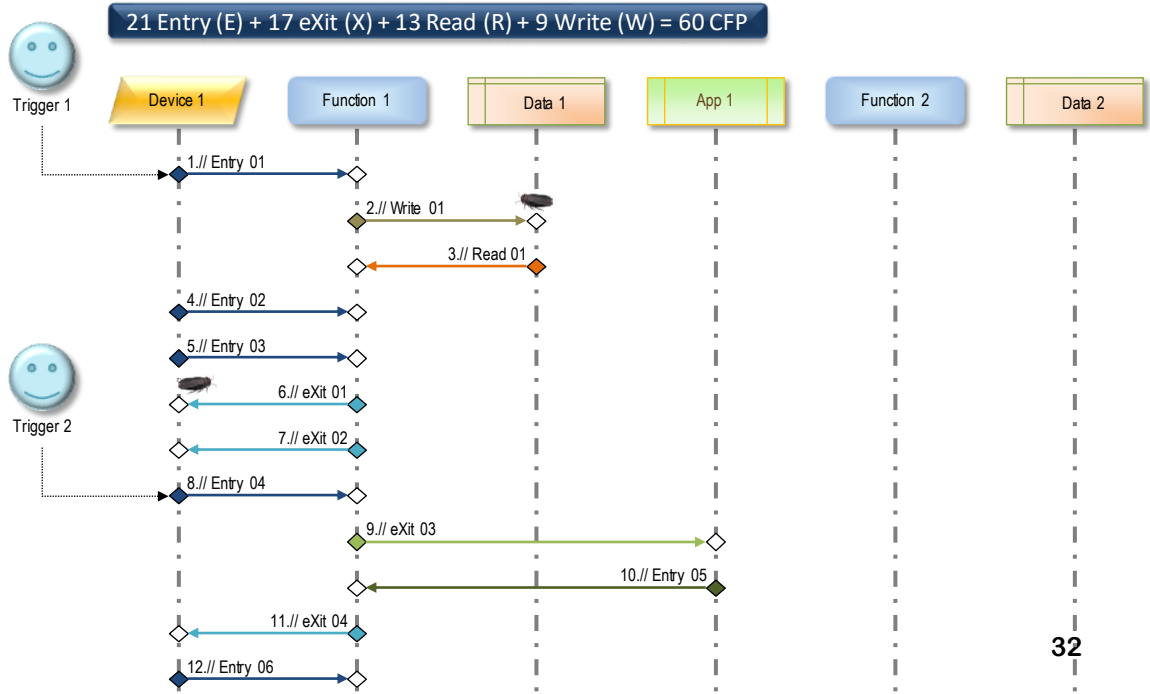
198 Total Test Size
0.10 Convergence Range
0.20 Convergence Limit

Autonomous Real-Time Testing – Step 5

- Run the Initial Tests
  - Count defects
  - Compare defects count with test response profile
    - If defects are equally spread the defects count profile should match the test response profile
    - If not, investigate special causes
- Repeat until defects are eliminated
  - It might be necessary to add more test stories and test cases
  - Keep convergence gap closed

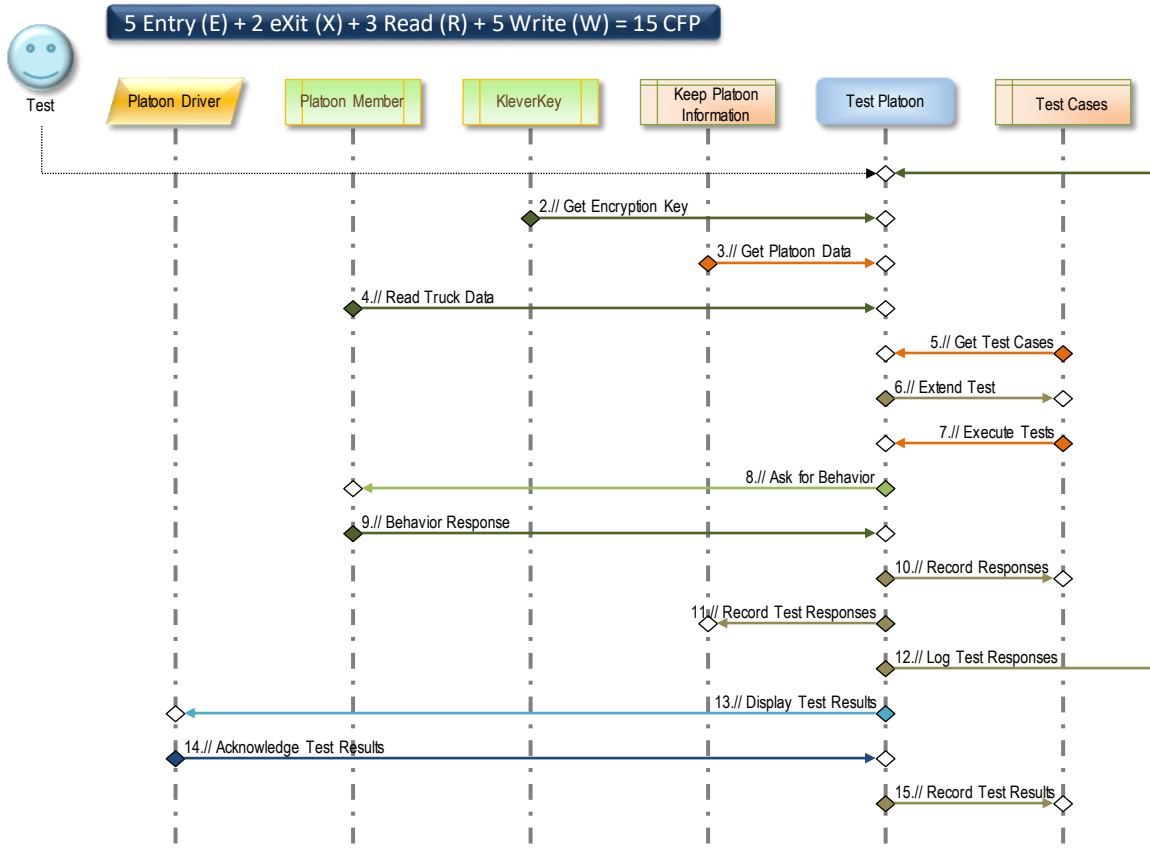
Test Case Measurements for Test Story Q1-3 ***Test Story No. 3*** ***Defects Observed***

Q1-3	*Test Story Q1-3*	*Expected Response*	CFP	*Name*	*Label*
Q1-3.1	Test Data Q1-3	Expected Response Q1-3	*4*		
Q1-3.2	Test Data Q1-3	Expected Response Q1-3	*2*	#002	Unit not checked
	Test Story Contribution (CFP):	***Test Size***	*6*	*1*	***Defect Count***



Autonomous Real-Time Testing – Step 6

- Set up the Automatic Test Generator
  - Generate Level 1 to Level 4 test cases
  - Count data movements automatically
  - Select test cases for execution based on convergence gap
  - Record test results to the cloud
- Do Dry Runs
  - Let trucks run; play the IoT concert!
  - Save test results to the cloud
  - Watch defects found
  - Watch convergence gaps



Autonomous Real-Time Testing – Step 7

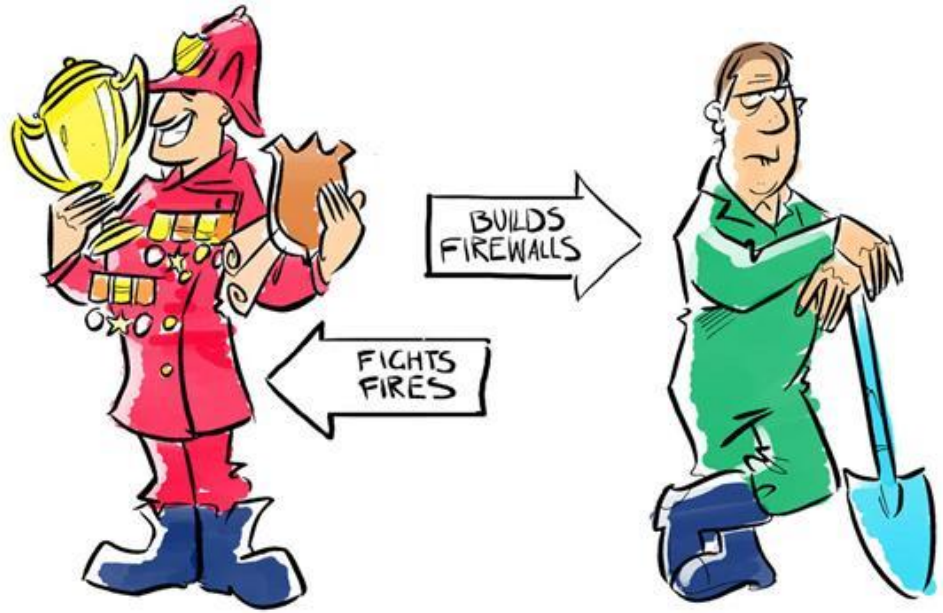
- Analyze Test Results
  - Compare defects with test response profile
  - Identify weak spots
    - If defects are equally spread the defects count profile should match the test response profile
    - If not, investigate special causes
- Act upon Findings
  - Continuously improve the behavior of autonomous systems

Test Status Summary

Total CFP:	60	Test Size in CFP:	198
		Test Intensity in CFP:	3.3
Defects Found in Total:	3	Defect Density:	1.5%
Defects Pending for Removal:	3	Data Moves Covered:	98%

Unresolved Problems and Weaknesses

- COSMIC counts are not mainstream
  - Important code quality tools such as SonarQube do not (yet) count functional size automatically
  - Testing metrics are virtually unknown
  - Customers do not understand neither size nor test metrics
  - The current hype for autonomous car driving hides the need for safety and privacy
- Approach is not easily carried over to ISO/IEC 20926 IFPUG Function Points



Conclusions

- Autonomous Real-Time Testing is something immediately needed that will become highly important in the near future
  - Autonomous cars never will hit the roads without autonomous real-time tests
  - IoT is bound for failure without autonomous real-time tests
  - ICT's future depends from autonomous real-time tests
- It's a good idea to get acquainted with the concept early enough
  - Autonomous things need Software Metrics!
  - Measure Software Tests!

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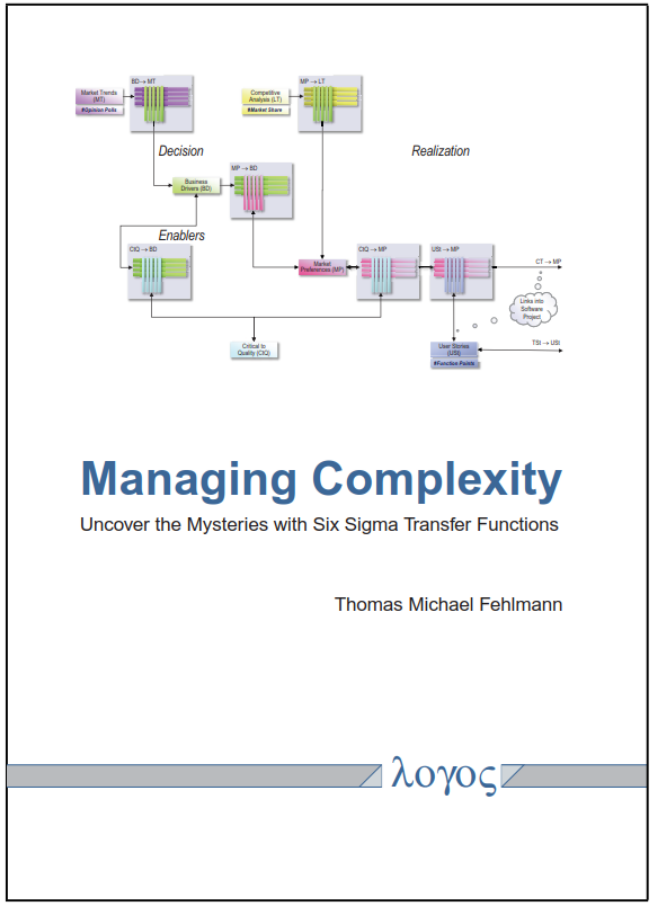
Questions?

- Customer Orientation
- Lean Six Sigma
- Agile Processes
- Project Estimations
- Transfer Functions

New Book on Six Sigma Transfer Functions



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