Faculty of Computer Science
Institute of Software and Multimedia Technology
Junior Professorship in Software Engineering of Ubiquitous Systems

TECHNISCHE UNIVERSITÄT DRESDEN

TEST MODELING FOR CONTEXT-AWARE UBIQUITOUS APPLICATIONS WITH FEATURE PETRI NETS
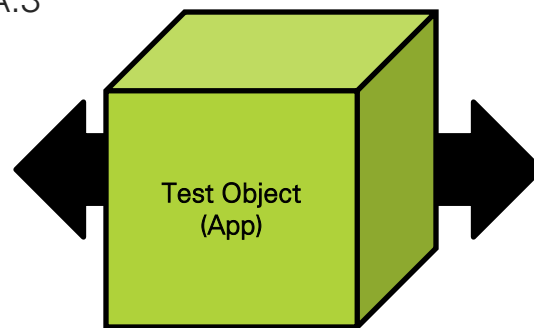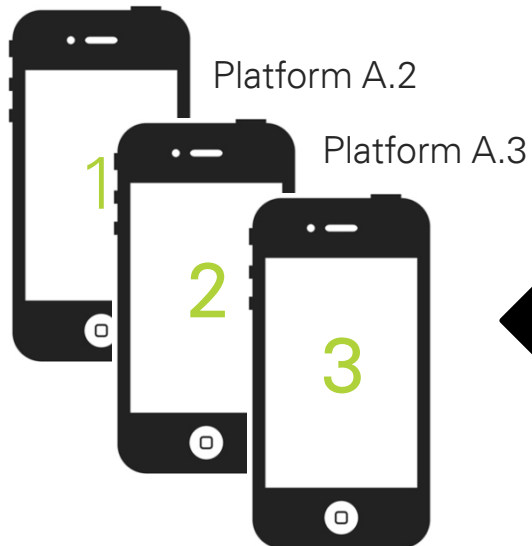
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Europa fördert Sachsen. SACHSEN
ESF
Europäischer Sozialfonds

T-Systems Multimedia Solutions

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OUTLINE

MOTIVATION – MOBILE APPLICATIONS (1)

■ Static variability

Platform A.1

Platform A.2

Platform A.3

Test Object (App)

Platform B.1
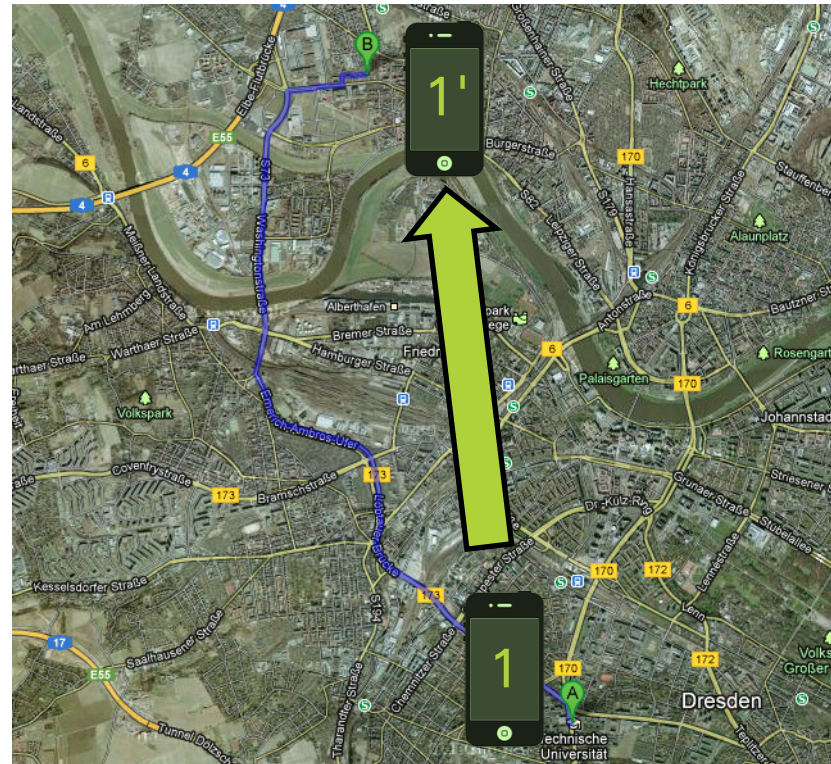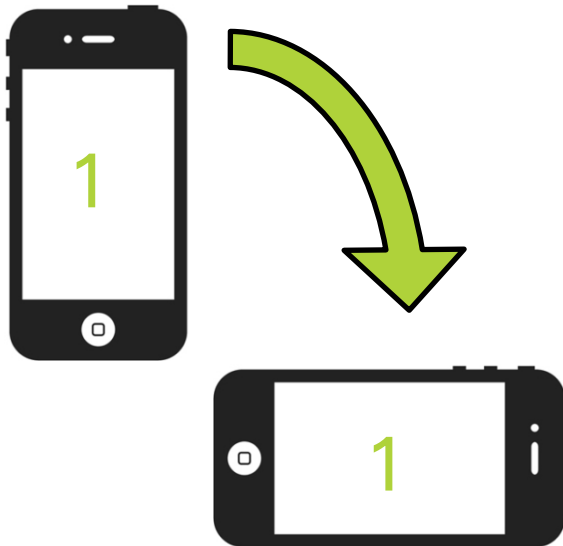
Platform B.2

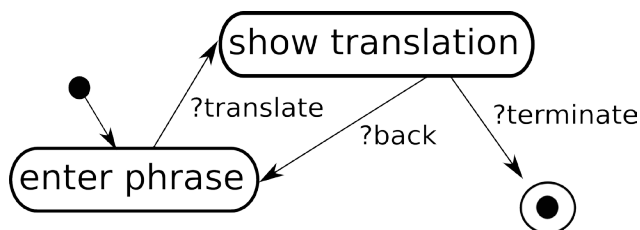# MOTIVATION – MOBILE APPLICATIONS (2)

- Dynamic variability

- Context changes: "external data, that may influence the application" [1]

TESTING OF UBIQUITOUS APPS – MAIN QUESTIONS

- Taming the feature and configuration space
- Validation of a ubiq. app against a common test model (despite multiple platforms)
- Modeling of dynamic changes (changing context)
- Description of test case coverage (equivalence classes)
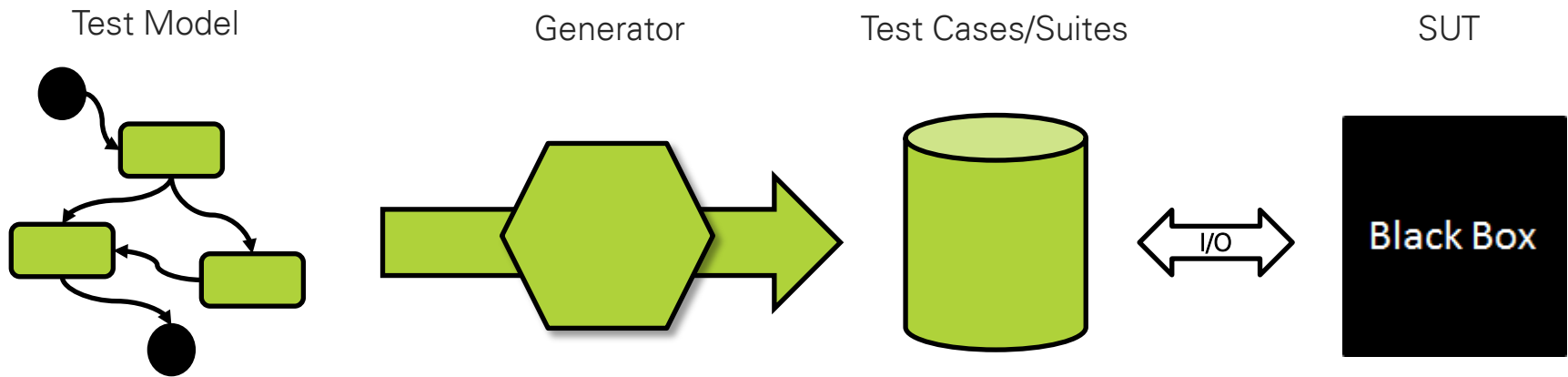- Automation of test case generation and reuse

EXAMPLE "TRANSAPP"

- Automatic language selection (location-based)
- Internet or local dictionary look-up (connection-based)

TECHNOLOGIES – MBT

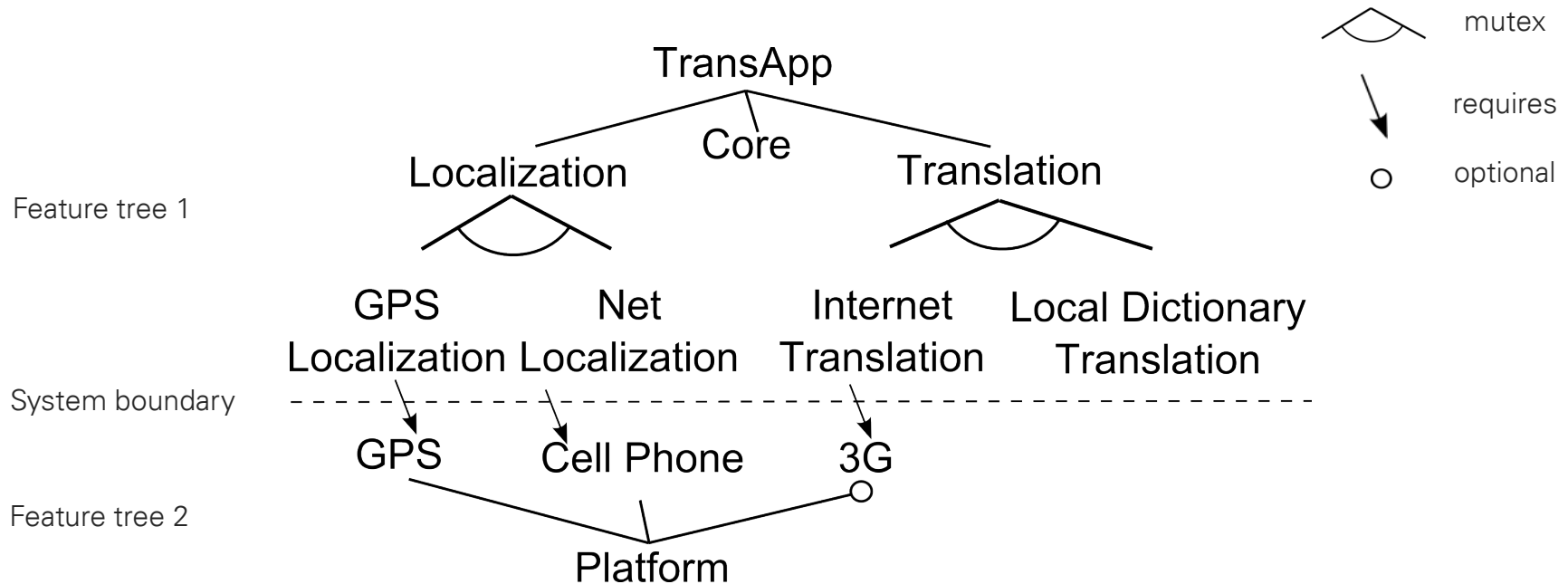■ "Model-based Testing is the automation of the design of black box tests." [2]

Test Model   Generator   Test Cases/Suites   SUT

■ Higher productivity through automation
■ Reusability
■ Measurable coverage
■ Traceability

TECHNOLOGIES – FEATURE MODELS

$FSsample = \{GPS\ Localization,\ Local\ Dictionary\ Translation,\ Core,\ GPS\}$
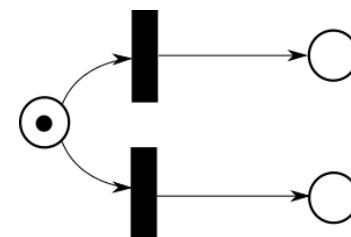
TECHNOLOGIES – DFPN (1)

- Dynamic Feature Petri Nets [3]
  - Transitions, places
  - Tokens, arcs
  - Control feature binding at runtime
  - Transitions extended by: $\dfrac{application\ condition}{update\ expression}$

- Application condition: defines for which configurations a transition may fire

$$\varphi ::= a \mid (\varphi \wedge \varphi) \mid (\varphi \vee \varphi) \mid \neg\varphi \mid true \ , \text{ with } a \in F$$

- Update expression: manipulates the feature configuration

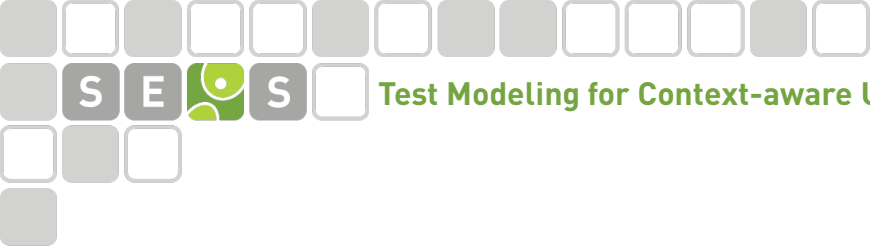$$u ::= \texttt{noop} \mid a \ \texttt{on} \mid a \ \texttt{off} \mid u; u \qquad [3]$$

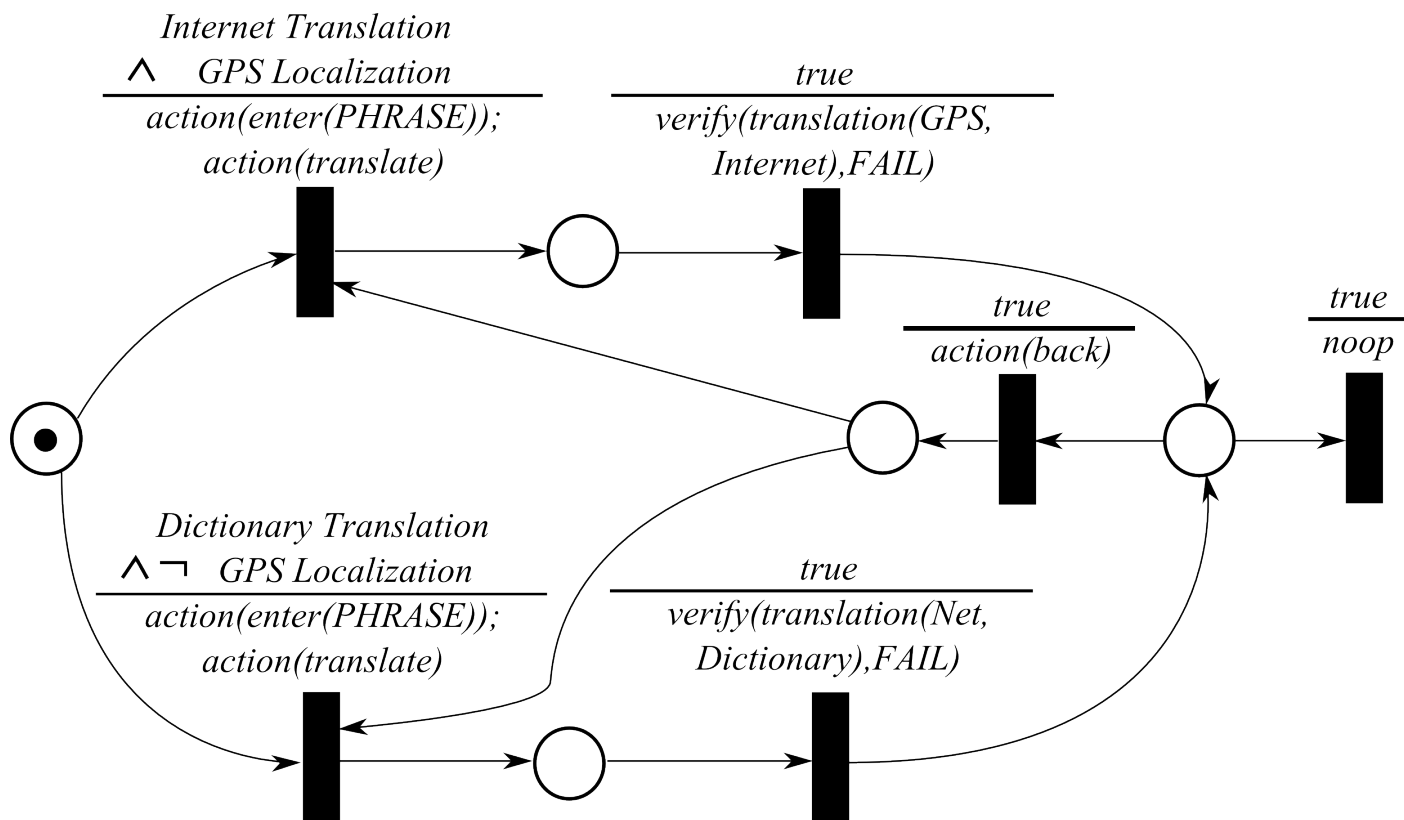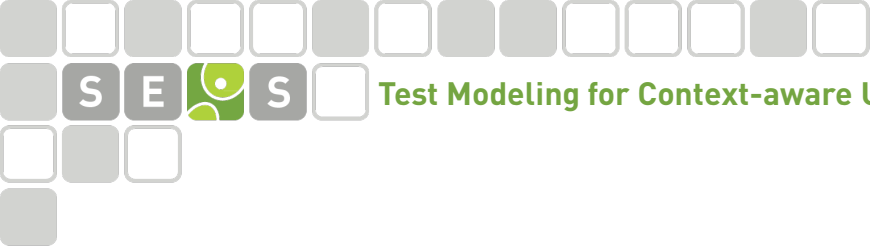$$u' ::= u \mid \texttt{action(x)} \mid \texttt{verify(x,v)} \mid u'; u'$$

v .. Verdict

x .. Term

Example: $\dfrac{Internet\ Translation \ \wedge\ GPS\ Localization}{\begin{array}{c}action(enter(PHRASE)); \\ action(translate)\end{array}}$
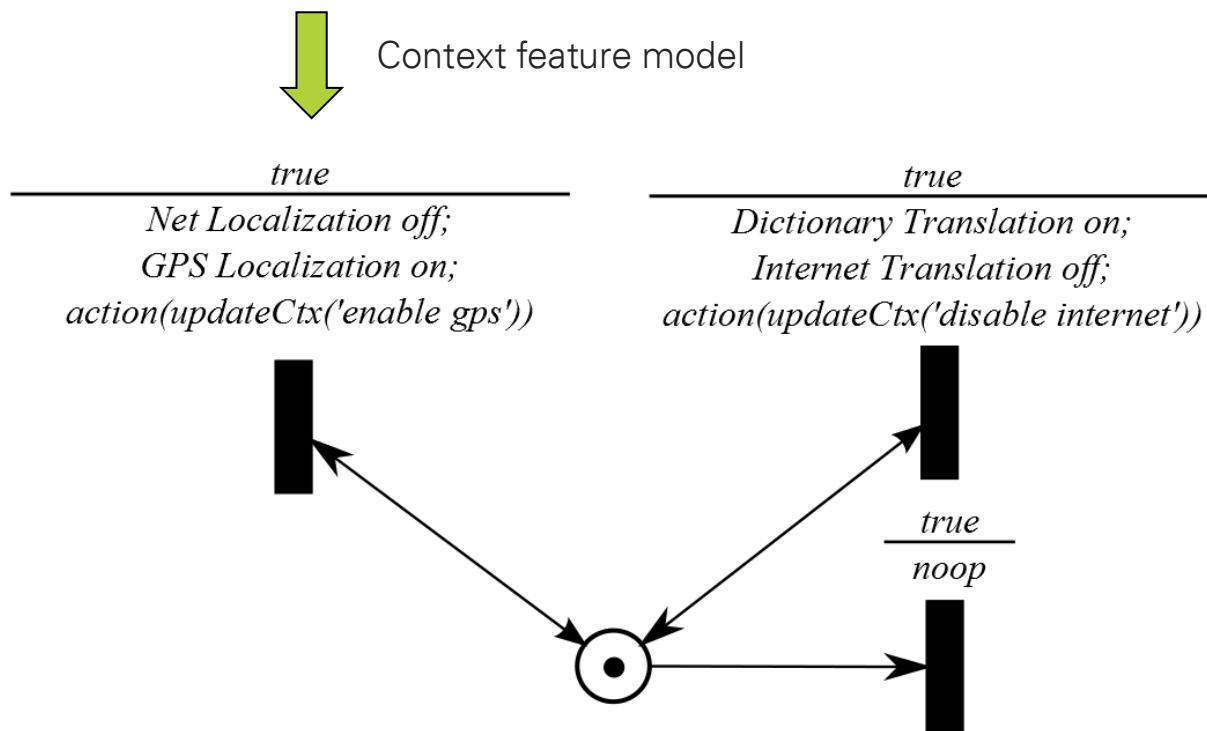
TECHNOLOGIES – DFPN (2)

TECHNOLOGIES – CONTEXT RULES

$$\varphi(\texttt{on|off}) \Rightarrow (\texttt{action(x)|verify(x,v)})$$

Example: $GPS\ Localization\ \text{on} \Rightarrow action('enable\ GPS')$

Context feature model

$$\frac{true}{\begin{array}{c}Net\ Localization\ off;\\GPS\ Localization\ on;\\action(updateCtx('enable\ gps'))\end{array}}$$

$$\frac{true}{\begin{array}{c}Dictionary\ Translation\ on;\\Internet\ Translation\ off;\\action(updateCtx('disable\ internet'))\end{array}}$$

$$\frac{true}{noop}$$

WORKFLOW FOR TEST CASE GENERATION

SAT .. SATisfiabilty
SUT .. System Under Test

TOOL SUPPORT

■ MATE – Mobile Application Test Environment (http://www.quality-mate.org)

(1) DFPN   (2) context rules   (3) feature model

CONCLUSION

- **Model-based testing** for automation of black box tests
- **Feature models** for coping with platform and feature complexity, esp. in ubiq. apps
- **Petri net-based models** for describing dynamic and static behavior
- **Context rules** for considering context changes
- **Workflow** for deriving test cases / test suites
- Advantages:
    - Extended formal description of test cases
    - Leveraging properties of Petri nets
    - Automation, reusability
    - Traceability, measurable coverage
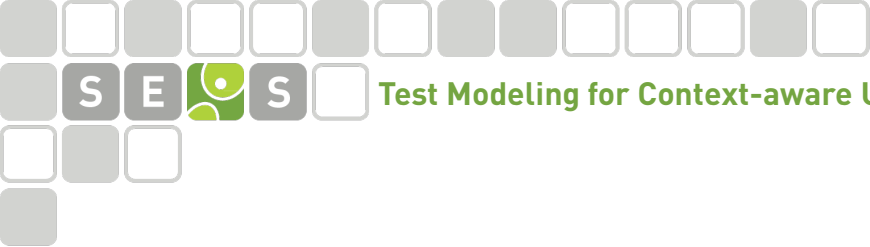- Modeling tool in ongoing development

TESTING IS FUN!

REFERENCES

[1] Dalmau, M., Roose, P., and Laplace, S. *Context aware adaptable applications - a global approach*. CoRR abs/0909.2090 (2009).

[2] Utting, M. *Practical model-based testing: a tools approach*. Morgan Kaufmann, 2007.

[3] Muschevici, R., Clarke, D., and Proenca, J. *Feature petri nets*. In Proceedings of the 14th International Software Product Line Conference (SPLC 2010) (2010).

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CREDITS

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