

How to Qubes?



Improving the learnability
of Qubes OS

Motivation

Usable secure operating systems
easy to learn for at risk populations.

Agenda

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- Introduction to Qubes OS

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- Related work

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- Related work
- Conducted exploratory research

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- Solution proposal

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- Evaluation methods

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- Solution proposal
- Evaluation methods
- Conclusion

Qubes Introduction

Contextualization

Converged MLS systems



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Converged MLS systems



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Converged MLS systems



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Converged MLS systems

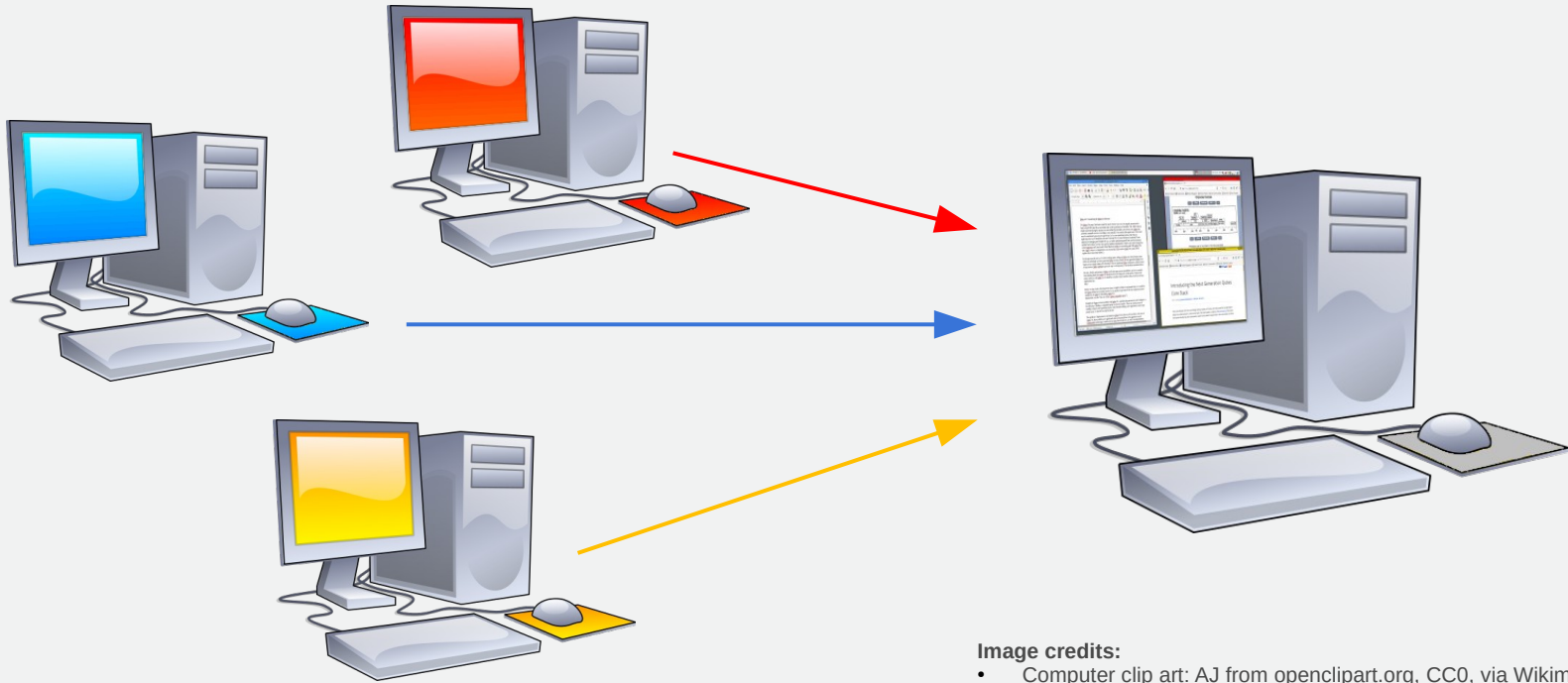


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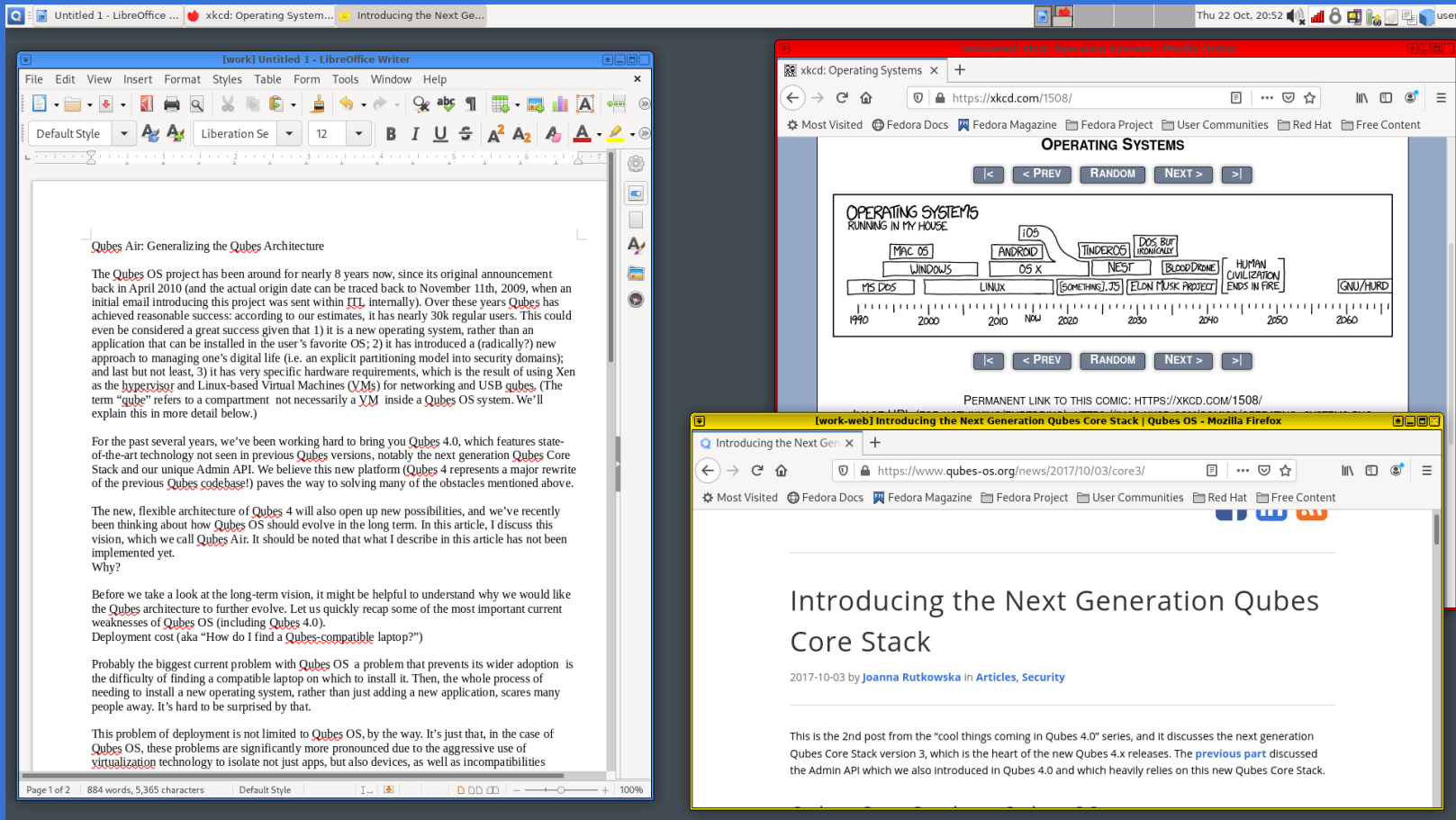


Figure: Qubes OS user interface

source: qubes-os.org

Qubes OS

Qubes OS

- FLOSS

Qubes OS

- FLOSS
- Targeted at at-risk populations

Qubes OS

- FLOSS
- Targeted at at-risk populations
- Welcoming community

Qubes OS

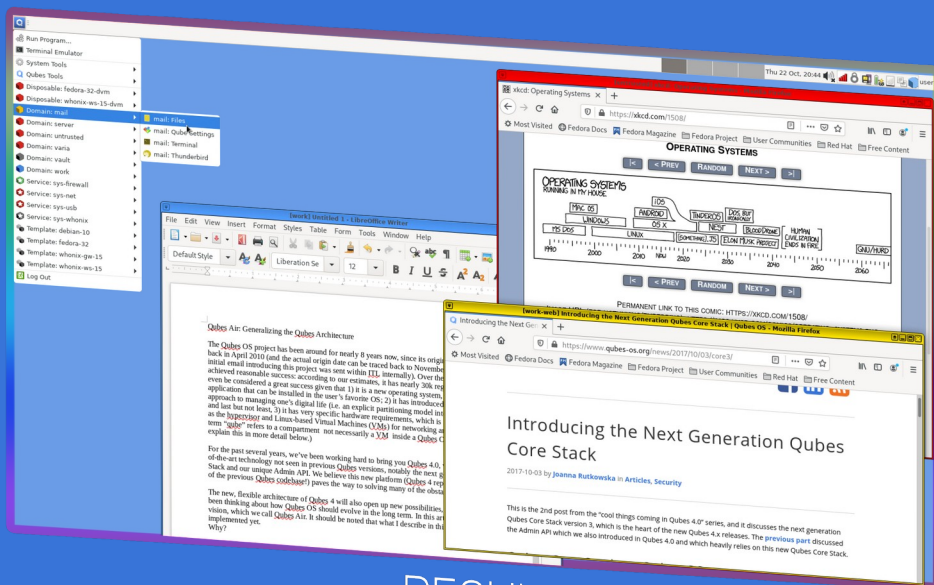
- FLOSS
- Targeted at at-risk populations
- Welcoming community
- Familiarity

Qubes OS

- FLOSS
- Targeted at at-risk populations
- Welcoming community
- Familiarity
- User research opportunities

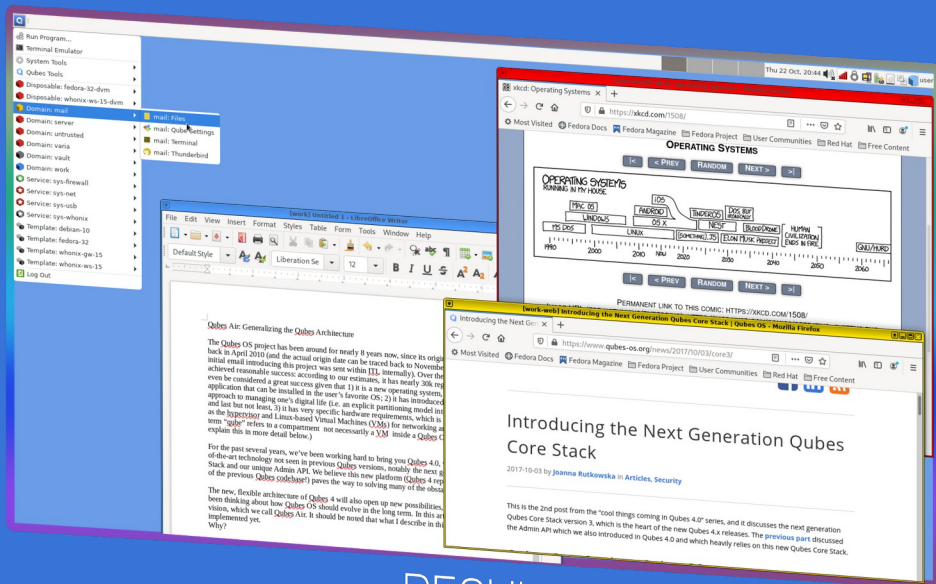
Qubes under the hood

User Interface



REGULAR USAGE PLANE

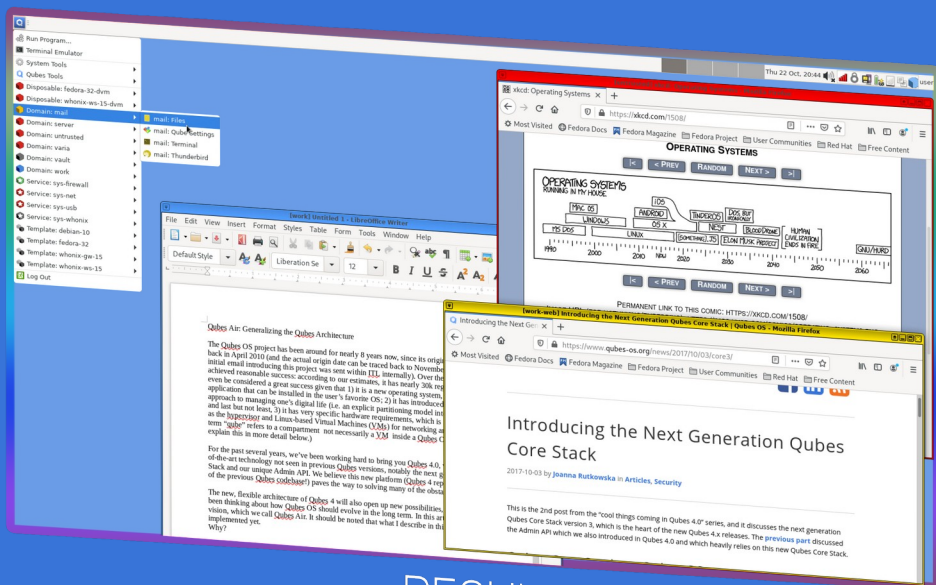
User Interface



- Starting / shutting down VM

REGULAR USAGE PLANE

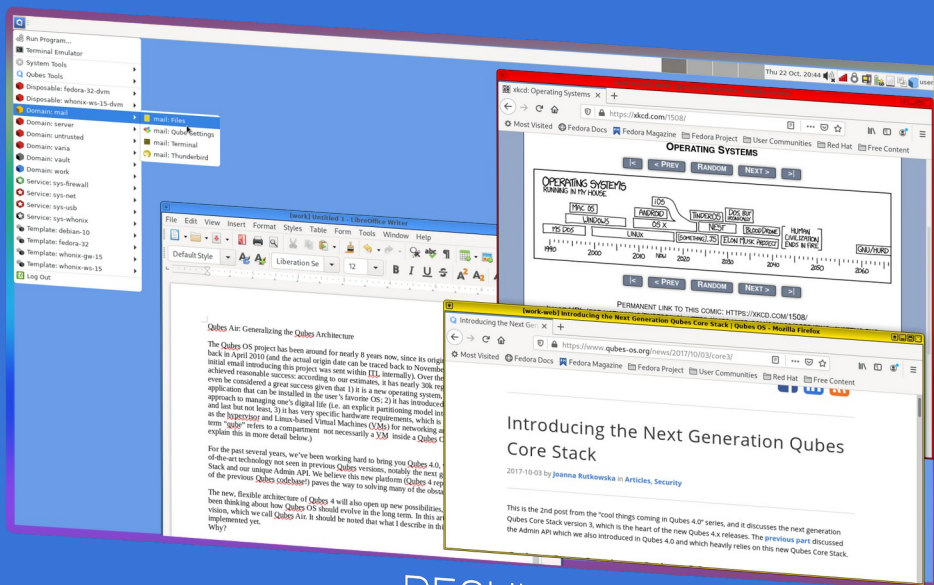
User Interface



- Starting / shutting down VM
- Copy & paste between VMs

REGULAR USAGE PLANE

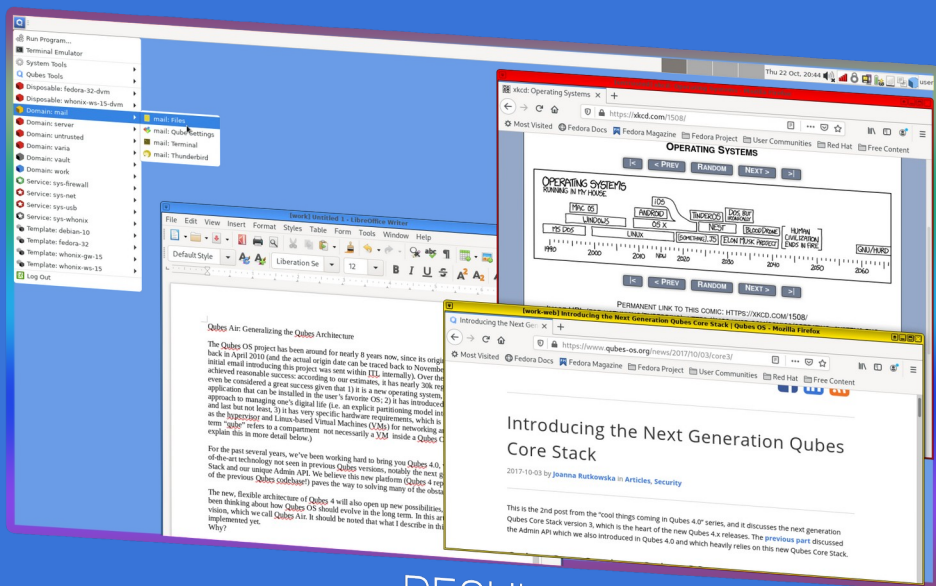
User Interface



- Starting / shutting down VM
- Copy & paste between VMs
- Copy files between VMs

REGULAR USAGE PLANE

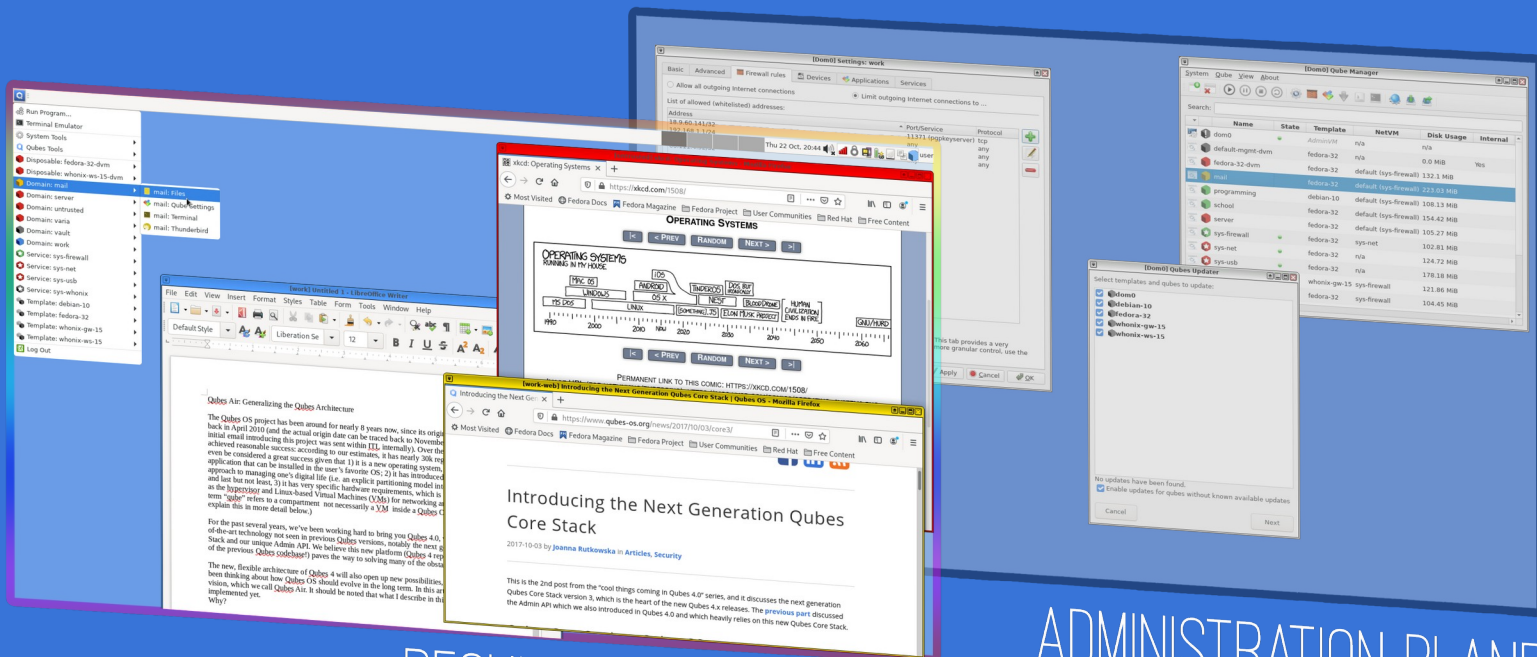
User Interface



- Starting / shutting down VM
- Copy & paste between VMs
- Copy files between VMs
- Attaching device to VM

REGULAR USAGE PLANE

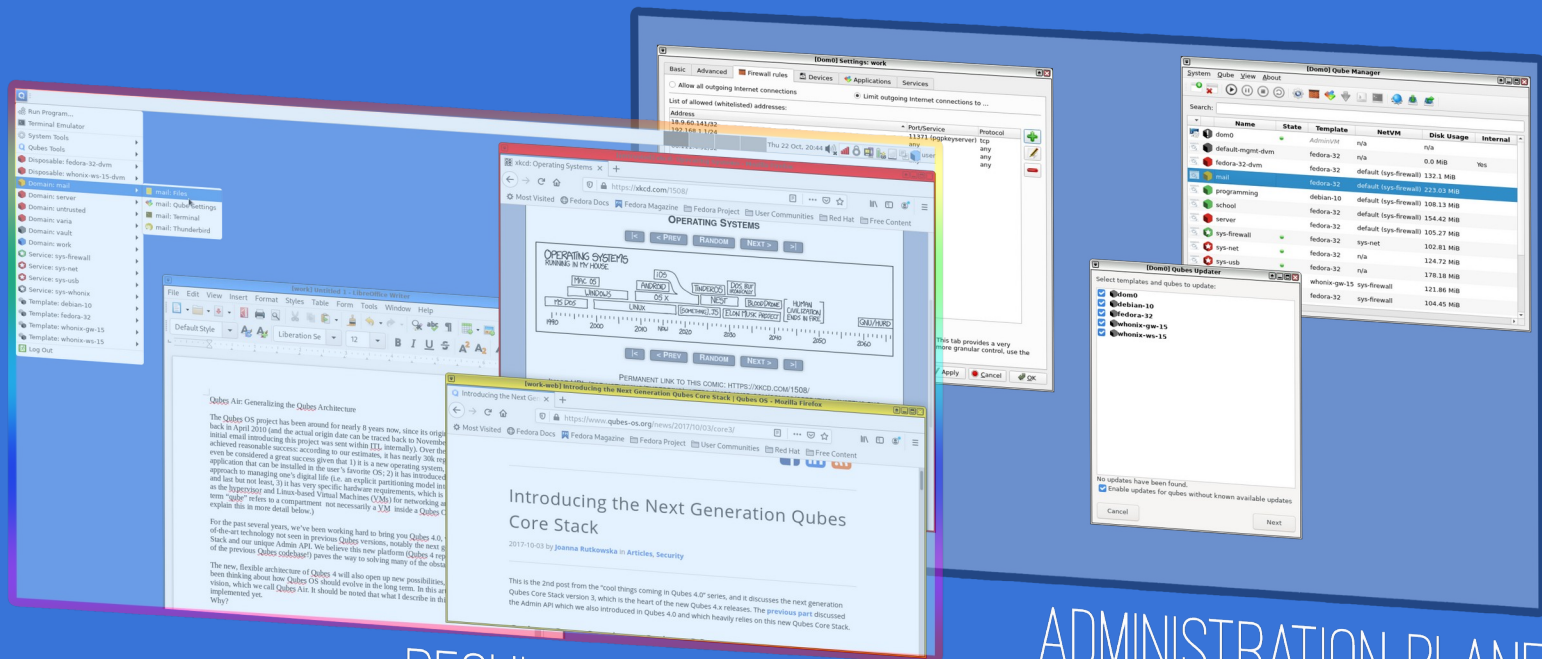
User Interface



REGULAR USAGE PLANE

ADMINISTRATION PLANE

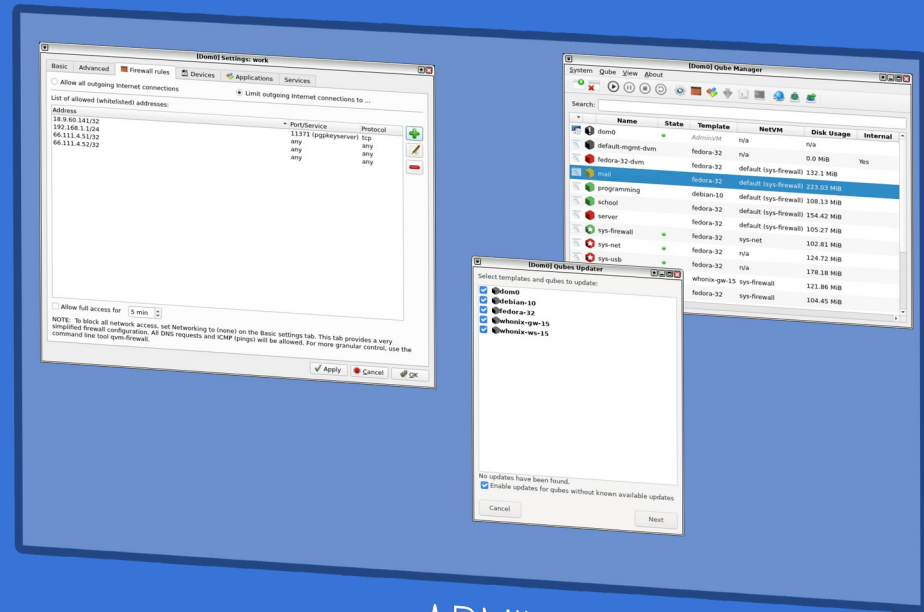
User Interface



REGULAR USAGE PLANE

ADMINISTRATION PLANE

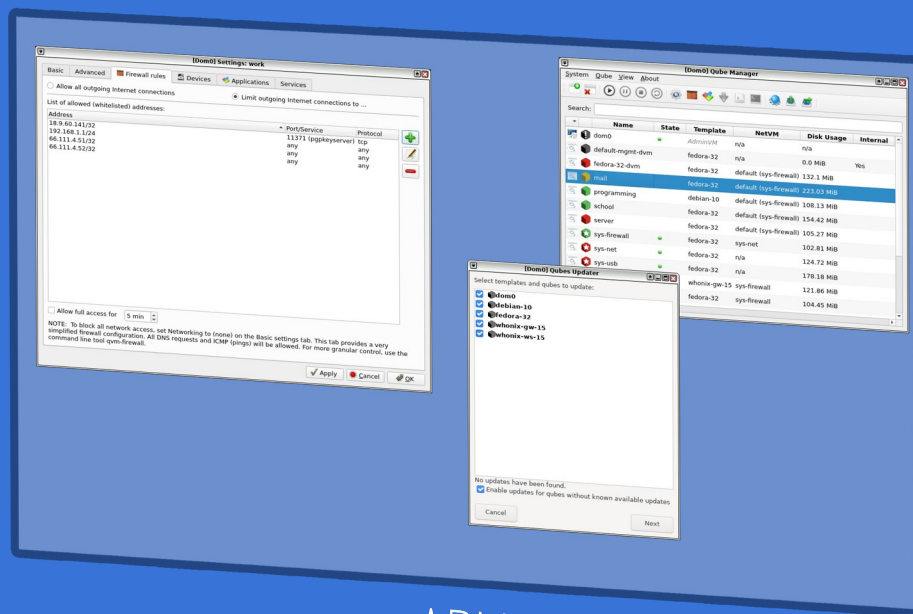
User Interface



ADMINISTRATION PLANE

User Interface

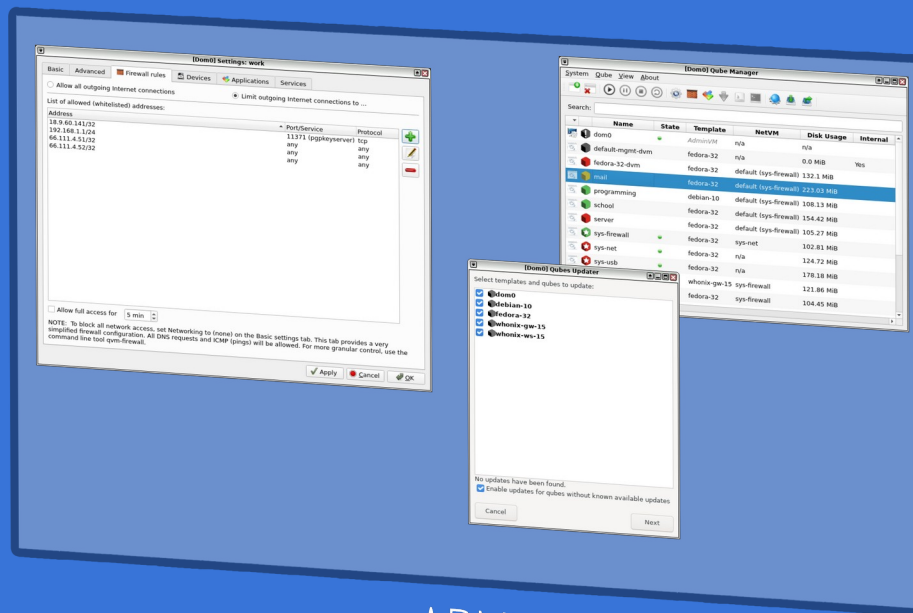
- Updating system



ADMINISTRATION PLANE

User Interface

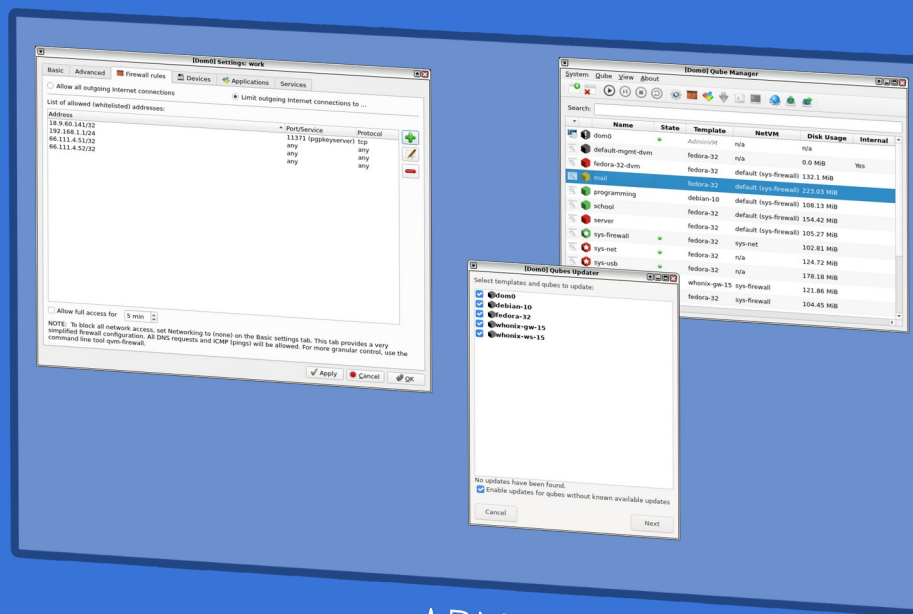
- Updating system
- Installing software



ADMINISTRATION PLANE

User Interface

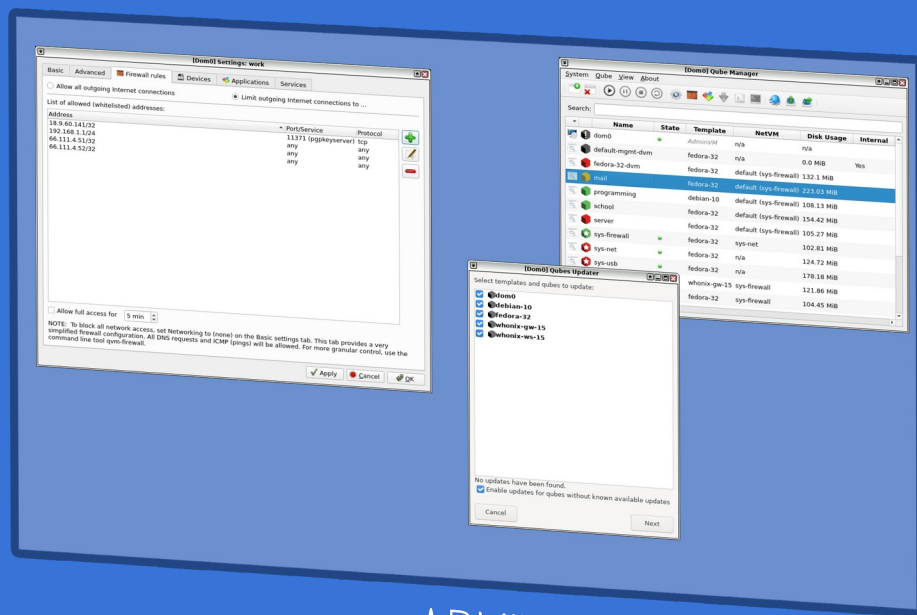
- Updating system
- Installing software
- Creating / deleting VM



ADMINISTRATION PLANE

User Interface

- Updating system
- Installing software
- Creating / deleting VM
- Configure network path



ADMINISTRATION PLANE

Related Work

Usable Security

- Poor understanding of the security systems leads to users undermining the security of the system

References:

Whitten, A., Tygar, J.D.: Why Johnny Can't Encrypt: A Usability Evaluation of PGP 5.0 p. 24.

Software Learnability

“The system should be easy to learn so that the user can rapidly start getting some work done with the system”

– *Jacob Nielsen, Usability Engineering*

Initial learnability

Extended learnability

References:

- Jakob Nielsen: Usability Engineering
- Grossman, T., Fitzmaurice, G., Attar, R.: A Survey of Software Learnability: Metrics, Methodologies and Guidelines p. 10 (2009)

Software Learnability

Research gap

Learnability of Converged MLS Systems

Stencils-based approach



References:

- Kelleher, C., Pausch, R.: Stencils-based tutorials: design and evaluation. In: Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '05. p. 541. ACM Press, Portland, Oregon, USA (2005).

Stencils-based approach

- Contextual procedural tutorials



References:

- Kelleher, C., Pausch, R.: Stencils-based tutorials: design and evaluation. In: Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '05. p. 541. ACM Press, Portland, Oregon, USA (2005).

Stencils-based approach

- Contextual procedural tutorials
- Tutorial as an interface overlay

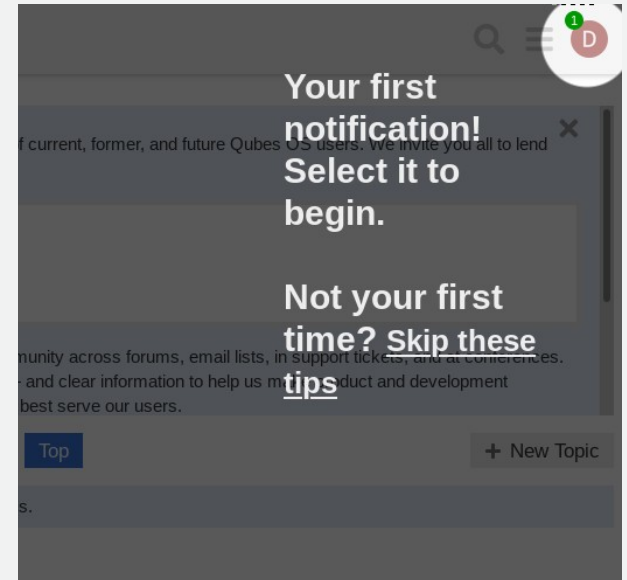


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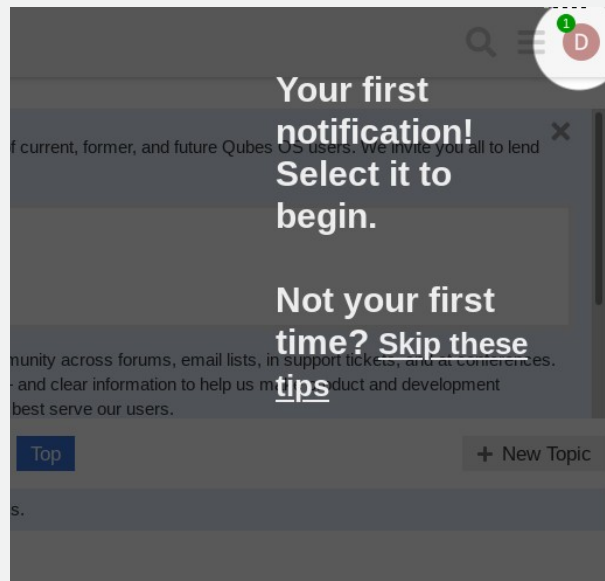


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Stencils-based approach

- Contextual procedural tutorials
- Tutorial as an interface overlay
- Compared to paper tutorials

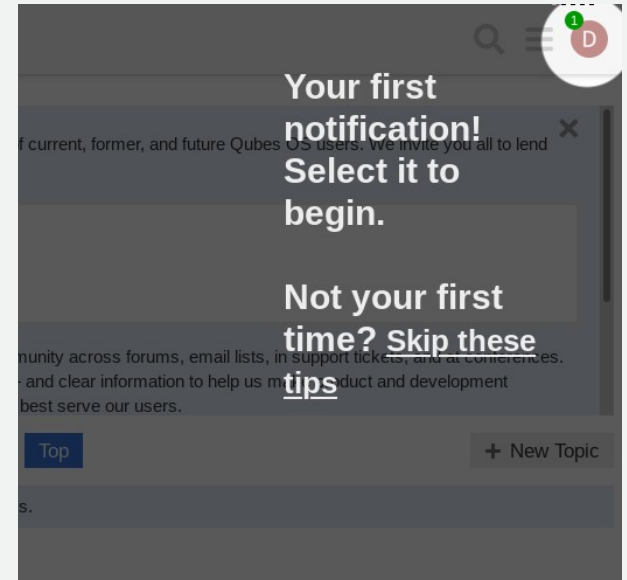


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Stencils-based approach

- Contextual procedural tutorials
- Tutorial as an interface overlay
- Compared to paper tutorials
 - Fewer errors



References:

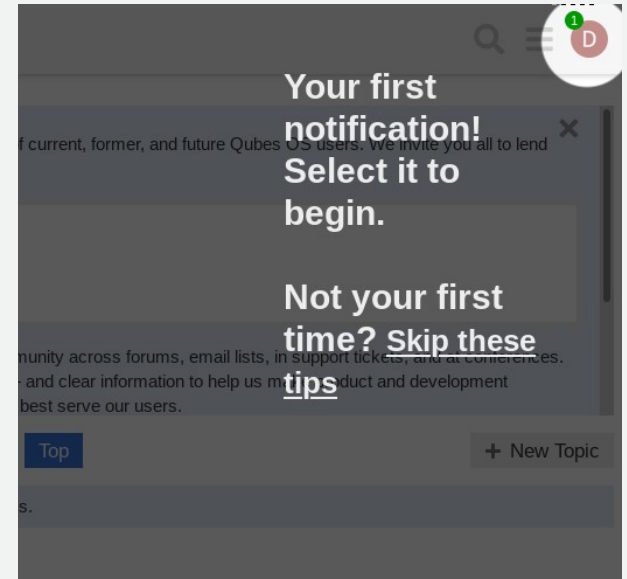
- Kelleher, C., Pausch, R.: Stencils-based tutorials: design and evaluation. In: Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '05. p. 541. ACM Press, Portland, Oregon, USA (2005).

Stencils-based approach

- Contextual procedural tutorials
- Tutorial as an interface overlay
- Compared to paper tutorials
 - Fewer errors
 - 26% less time

References:

- Kelleher, C., Pausch, R.: Stencils-based tutorials: design and evaluation. In: Proceedings of the SIGCHI conference on Human factors in computing systems - CHI '05. p. 541. ACM Press, Portland, Oregon, USA (2005).



Usage of Manuals

- Users prefer learning by doing
- Trial-and-error more frequent than manual

References:

- Novick, D.G., Andrade, O.D., Bean, N.: The micro-structure of use of help. In: Proceedings of the 27th ACM international conference on Design of communication - SIGDOC '09. p. 97. ACM Press, Bloomington, Indiana, USA (2009).
- Jakob Nielsen: Usability Engineering

Gamified Onboarding

- Definition of gamification
- Elements include: *Points, Achievements/Badges, Levels, Story/Theme, Feedback, Rewards, Progress, Challenge.*
- *User onboarding definition*
- Effective methods for instruction (meta-analysis)

References:

- Hamari, J., Koivisto, J., Sarsa, H.: Does Gamification Work? – A Literature Review of Empirical Studies on Gamification. In: 2014 47th, Hawaii International Conference on System Sciences.
- Sailer, M., Homner, L.: The Gamification of Learning: a Meta-analysis. Educational Psychology Review 32(1), 77–112 (Mar 2020).

Conducted Research

Exploratory research on Qubes learnability

Research Goals

Understand the main learnability issues
with Qubes OS

- Main challenges when getting started (R1)
 - Solutions to challenges (R2)
 - Learning tools (R3)

Methodology

- Semi-structured interviews
- 6 participants

Conclusions

main challenges getting started (R1)

- User confusion on first contact
 - “you install the Qubes on the computer, but there is no onboarding. So you are alone with this new operating system [...] (P3)”
- Learning mechanics / features
 - installing software
 - installing windows
 - Copy clipboard / files across VMs
 - Discovering advanced features

Conclusions

main challenges getting started (R1)

Conclusions

main challenges getting started (R1)

Psychological Challenges

- Changing work-flows
- Compartmentalizing

Conclusions

main challenges getting started (R1)

Psychological Challenges

- Changing work-flows
- Compartmentalizing

Mental Model Formation

- Differences between types of VMs
- Coming from Linux
- Understanding networking

Conclusions

main challenges getting started (R1)

Psychological Challenges

- Changing work-flows
- Compartmentalizing

Mental Model Formation

- Differences between types of VMs
- Coming from Linux
- Understanding networking

Many technical challenges

Conclusions

solutions to challenges (R2)

Changing work-flow

- Compartmentalizing before
- Model current work-flows

Compartmentalization

- Using the default configuration
- Following others' strategies
- Starting with small number of VMs
- Splitting VMs into smaller

Conclusions

learning tools (R3)



A word cloud containing various terms related to learning Qubes OS. The most prominent word is 'documentation' in large green font. Other words include 'videos', 'linux helped', 'Qubes Forum', 'Qubes riot', 'googling', 'play around with it', 'Blog Posts', 'friends w/ Qubes', 'mailing list', 'going slowly', and '/r/Qubes'.

friends w/ Qubes
play around with it
mailing list Blog Posts
going slowly /r/Qubes
documentation
videos googling
linux helped
Qubes Forum
Qubes riot

Conclusions

learning tools (R3)



A word cloud containing the following terms: friends w/ Qubes, play around with it, mailing list, Blog Posts, going slowly, /r/Qubes, documentation, videos, googling, linux helped, Qubes Forum, and Qubes riot. The word 'documentation' is the largest and most prominent.

Important

What was not mentioned

Conclusions

learning tools (R3)



A word cloud containing the following terms: friends w/ Qubes, play around with it, mailing list, Blog Posts, going slowly, /r/Qubes, documentation, videos, googling, linux helped, Qubes Forum, and Qubes riot. The word 'documentation' is the largest and most prominent.

Important

What was not mentioned

The system!

Solution Proposal

Motivation

- Need for external documentation
- Most users prefer to “just learn as you go”
- Gamification helps learning

Two Components

Two Components

Onboarding
Interactive Tutorial

Two Components

Onboarding
Interactive Tutorial

Achievements
Companion Application

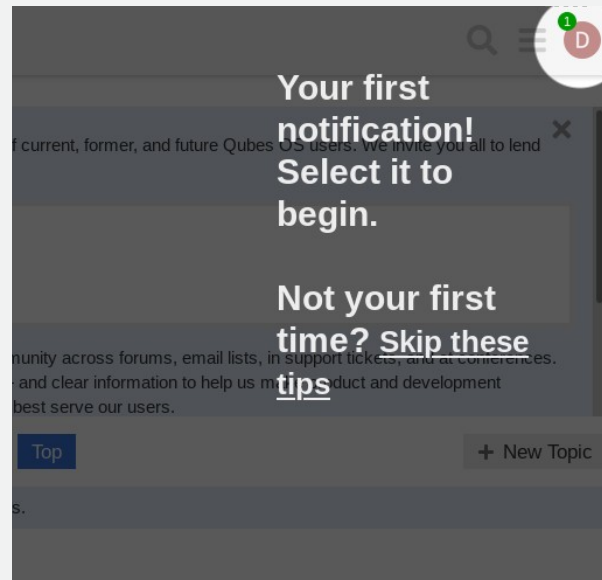
Onboarding Interactive Tutorial

Onboarding Interactive Tutorial

- Introduce user to the system:
 - Base concepts
 - Advice
 - Basic Tasks

“Stencils”-based approach

Guide the user through the interface



Other ideas

Other ideas

Progression

Showing users the number of steps left

Other ideas

Progression

Showing users the number of steps left

Feedback

Offer “achievement” at the end of the tutorial

Achievements Companion Application

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Component Goal

Achievements Companion Application

Component Goal

- Show a progression path

Achievements Companion Application

Component Goal

- Show a progression path
- Promote discovery of features

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Complements onboarding tutorial

Achievements Companion Application

Component Goal

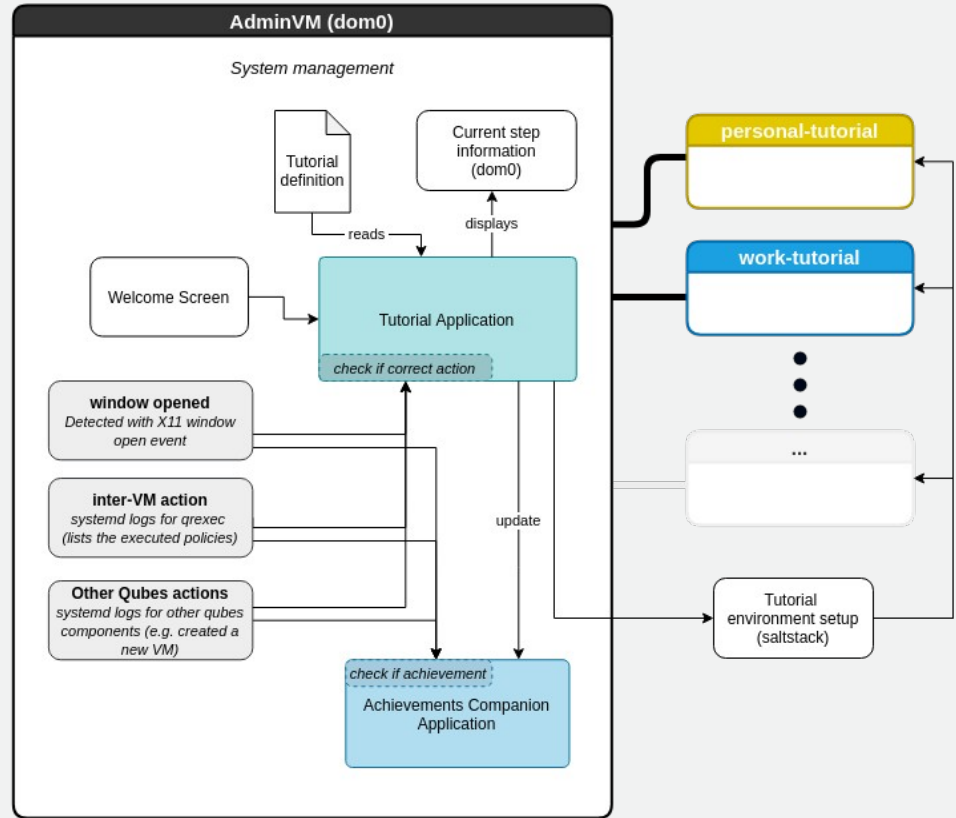
- Show a progression path
- Promote discovery of features

Complements onboarding tutorial

- Completion yields achievements

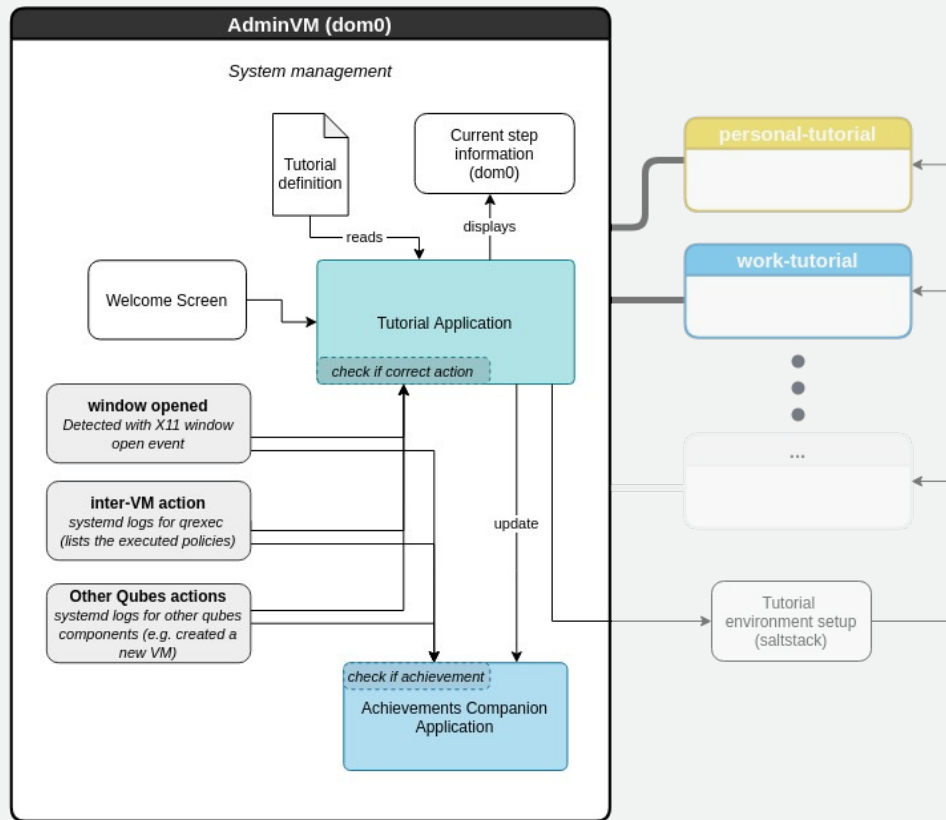
Solution Architecture

Architecture



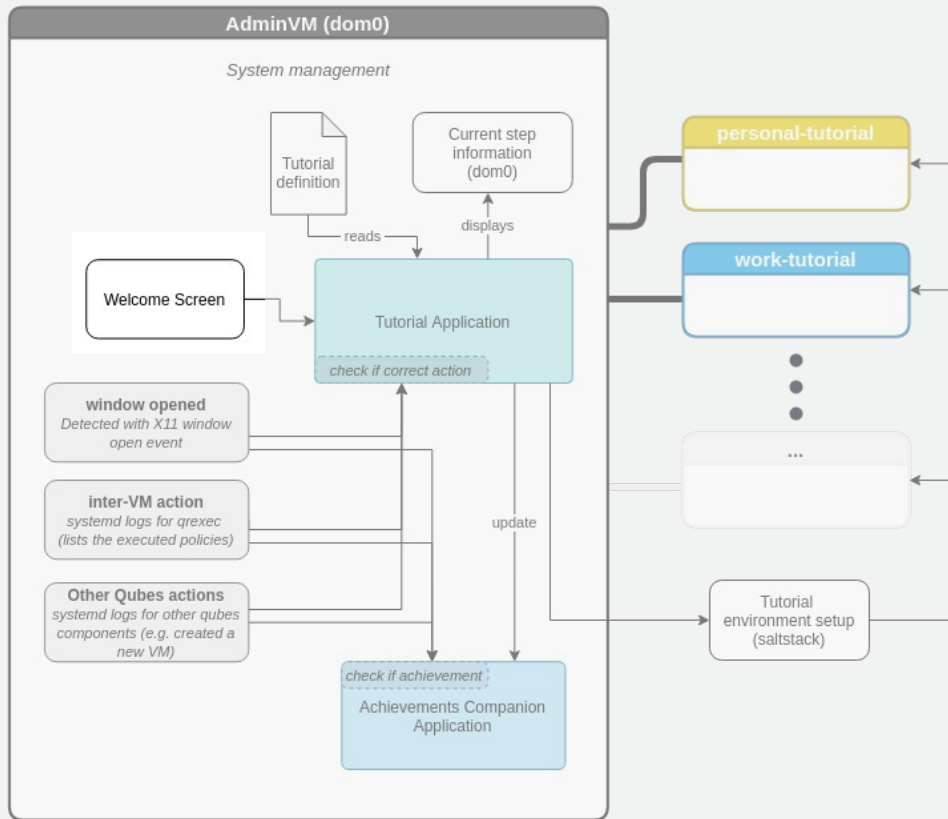
Architecture

1) Core logic in *dom0*



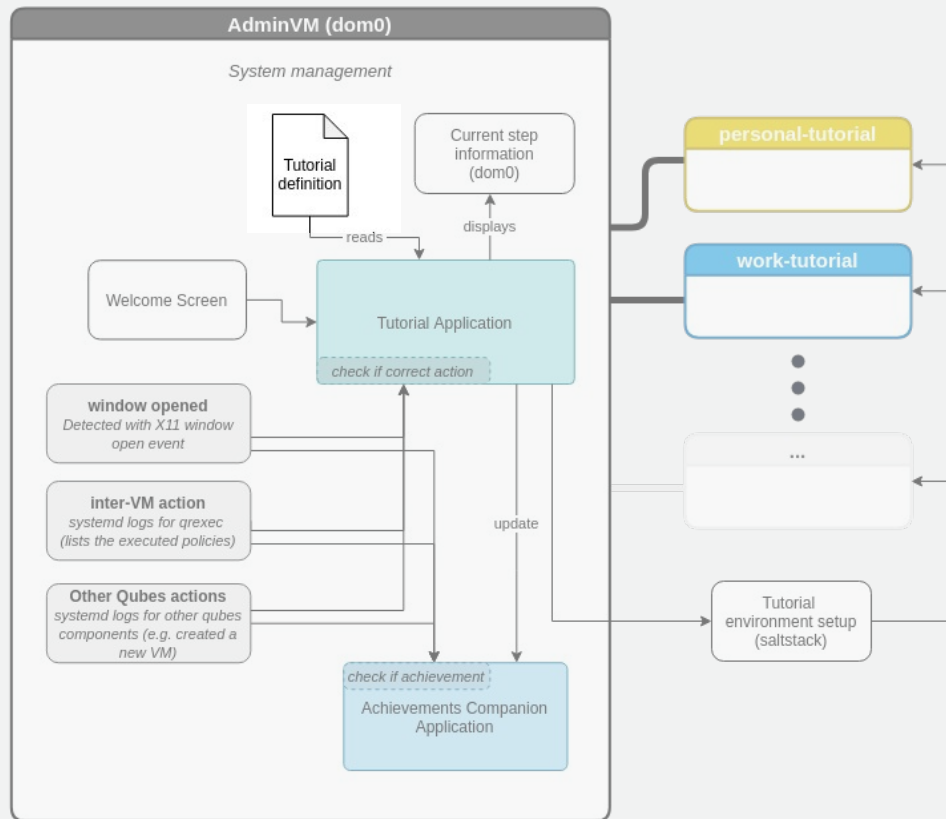
Architecture

- 1) Core logic in *dom0*
- 2) *Welcome screen*



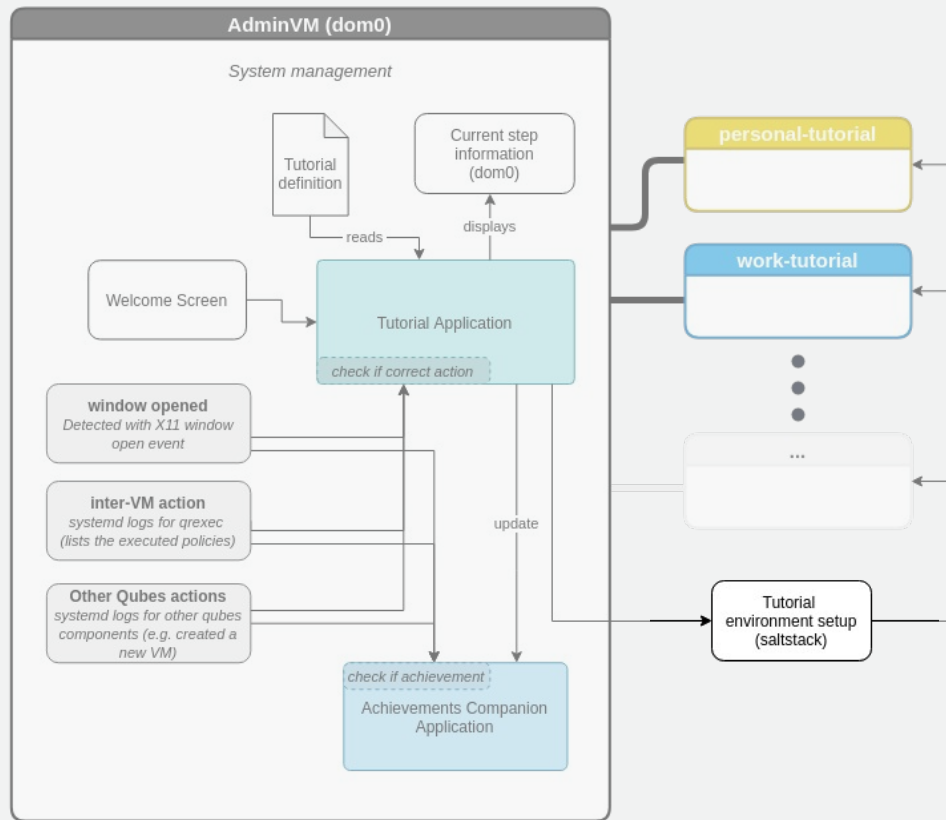
Architecture

- 1) Core logic in *dom0*
- 2) *Welcome screen*
- 3) Tutorial definition file



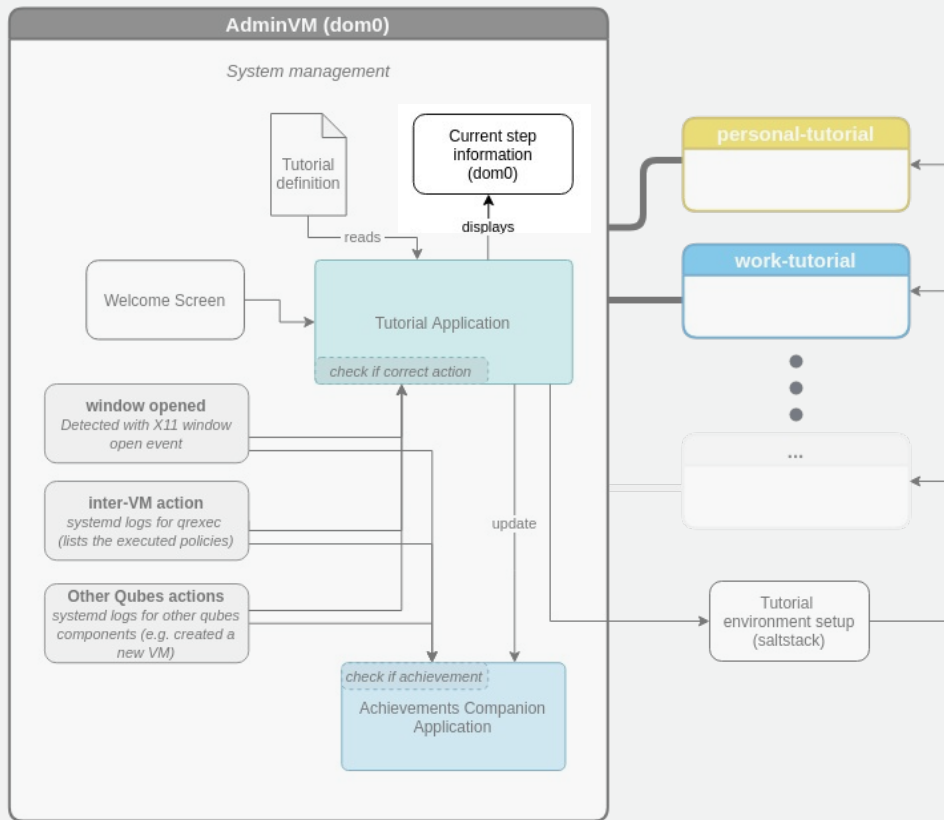
Architecture

- 1) Core logic in *dom0*
- 2) *Welcome screen*
- 3) Tutorial definition file
- 4) Environment setup



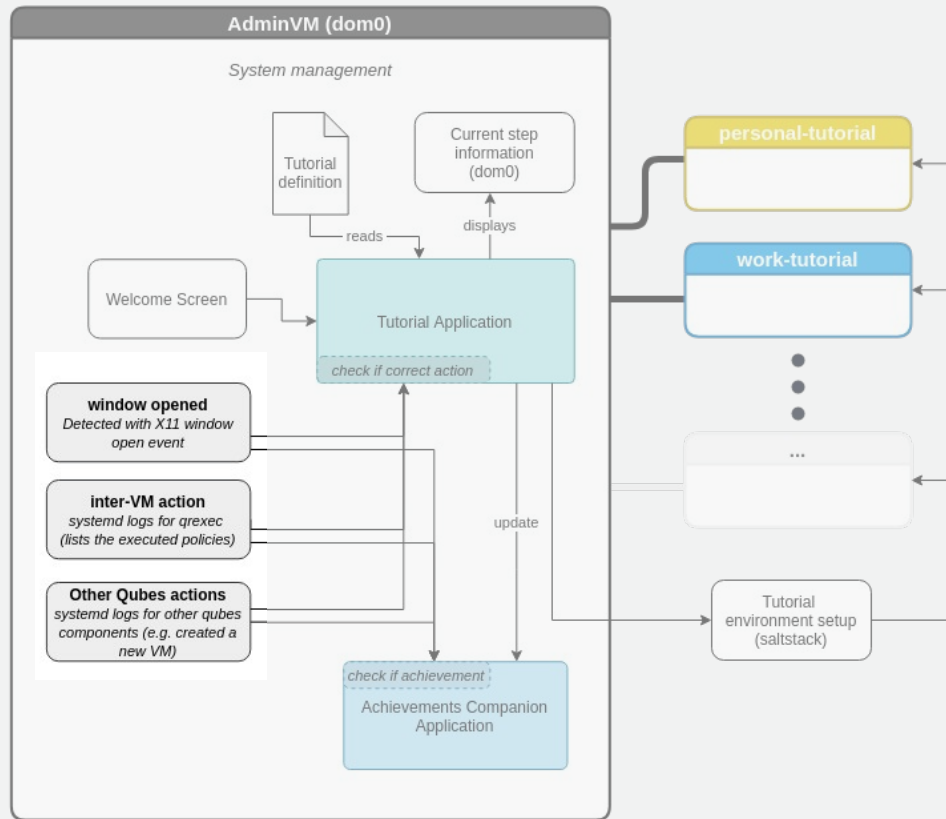
Architecture

- 1) Core logic in *dom0*
- 2) *Welcome screen*
- 3) Tutorial definition file
- 4) Environment setup
- 5) Present current step



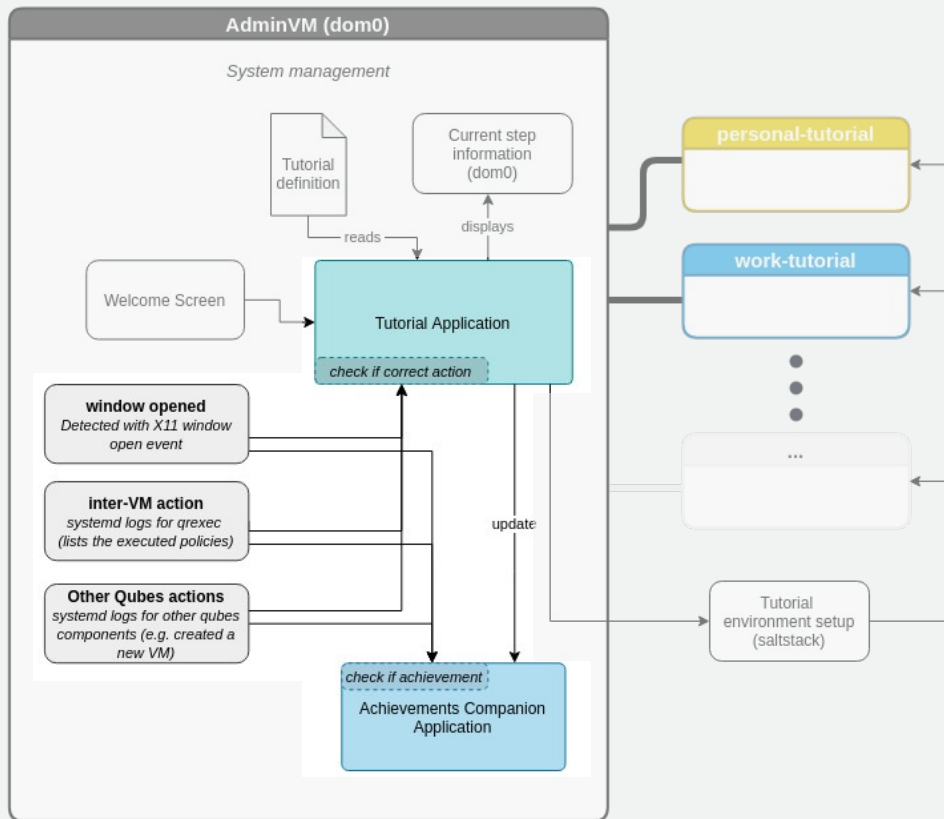
Architecture

- 1) Core logic in *dom0*
- 2) *Welcome screen*
- 3) Tutorial definition file
- 4) Environment setup
- 5) Present current step
- 6) Event logs consumption



Architecture

7) Update achievements



Evaluation Methods

How the solution will be evaluated

Evaluation Methods

Goal

- *Measure initial learnability*

Metrics

- *Total time on task*
- *Learning time for task*

Reference:

Grossman, T., Fitzmaurice, G., Attar, R.: A Survey of Software Learnability: Metrics, Methodologies and Guidelines p. 10

Evaluation Methods

Goal

- Measure *onboarding tutorial enrollment*

Metrics

- *% of tutorial enrollments*
- *% completed tutorials*

Evaluation Methods

Goal

- Measure mental model change

Metrics

- *Pre-test mental model evaluation*
- *Post-test mental model evaluation*

} *Multiple-choice
questionnaire*

Reference:

Paymans, T.F.: Usability trade-offs for adaptive user interfaces: ease of use and learnability p. 3

Testing Environment

Testing Environment

Remote testing

- *Remote screen via browser (similar to DistroTest)*

Testing Environment

Remote testing

- *Remote screen via browser (similar to DistroTest)*

Presential Testing

- Easier to configure
- Less scaling

Recruitment

Recruitment

Target demographic

- *Non-Qubes users (already interested)*

Conclusion

Thank You
