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# On achievable non-linear behaviors

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## 1 Abstract

The behavioral approach to systems and control theory has led to an elegant characterization of the set of all behaviors which are achievable by interconnecting (on a set of *shared variables*) a given linear time-invariant system (the *plant*) with another arbitrary linear time-invariant system (the *controller*). This characterization (in some circles known as *Willems' lemma*) takes the form of a double inclusion

$$\mathfrak{N} \subset \mathfrak{R} \subset \mathfrak{P}$$

with  $\mathfrak{R}$  denoting an achievable behavior, and  $\mathfrak{N}$  and  $\mathfrak{P}$  denoting, respectively, the *hidden* and the *manifest* plant behavior, see e.g. [1, 2, 3].

Purpose of this presentation is to give an alternative, and supposedly simpler, proof of this lemma, and to show how this alternative proof directly leads to a *nonlinear* generalization of Willems' lemma. Also some implications to the control of port-Hamiltonian (nonlinear) systems will be indicated.

## References

- [1] J.C. Willems, H.L. Trentelman, Synthesis of dissipative systems using quadratic differential forms, to appear.
- [2] H.L. Trentelman, A truly behavioral approach to the  $H_\infty$  control problem. In J.W. Polderman and H.L. Trentelman, editors, *The Mathematics of Systems and Control: from Intelligent Control to Behavioral Systems*, pp. 177-190, 1999.
- [3] J. W. Polderman, I. Mareels, A behavioral approach to adaptive control, In J.W. Polderman and H.L. Trentelman, editors, *The Mathematics of Systems and Control: from Intelligent Control to Behavioral Systems*, pp. 119-130, 1999.